

The Canadian Entomologist

Vol. LXXXIII

Ottawa, Canada, December 1951

No. 12

A Study of the Genus *Paradejeania* Brauer and Bergenstamm (Diptera: Tachinidae or Larvaevoridae)

By PAUL H. ARNAUD

Natural History Museum, Stanford University, California

This study of the genus *Paradejeania* Brauer and Bergenstamm was originally undertaken to determine the status to be accorded the western North American representative of this genus. It has been concluded that the single North American species of this genus—*rutilioides*—is polytypic, so that a new subspecies is proposed for the western North American form. An undescribed species from Colombia has also been available for study, through the kindness of Dr. C. Howard Curran, and is herein described, thus establishing the occurrence of the genus *Paradejeania* in South America.

Specimens have been studied from a number of institutional and private collections and the following abbreviations have been used in the text to denote the owners: (CAS)—California Academy of Sciences; (CBES)—California Bureau of Entomology, Sacramento; (CESR)—Citrus Experiment Station, Riverside; (HJR)—Prof. H. J. Reinhard; (OSC)—Oregon State College; (PHA)—P. H. Arnaud; (SJSC)—San Jose State College; (SU)—Stanford University; (UC)—University of California; (UI)—University of Idaho; (USAC)—Utah State Agricultural College; (USNM)—United States National Museum.

The descriptive terminology used in this paper is that of Townsend as outlined in Part 2 of his "Manual of Myiology".

Paradejeania Brauer and Bergenstamm

Generic type: *Dejeania rutilioides* Jaennicke, by original designation.

Bibliography of the genus *Paradejeania*.

- 1893 Brauer & Bergenstamm, Denkschr. Ak. Wiss., 60: 147 & 184.
- 1908 Adams, in; Williston, Man. N. A. Dipt., 377.
- 1910 Coquillett, Proc. U. S. Nat. Mus., 37(1719): 584.
- 1911 Townsend, Ann. Ent. Soc. Amer., 4(2): 132 & 143.
- 1913 Townsend, Psyche, 20(3): 102-104.
- 1920 Engel, Zool. Jahrb. Syst., 43(1-4): 275-276.
- 1934 Curran, Fam. & Gen. N. A. Dipt., 423, fig. 60 on 426.
- 1936 Townsend, Man. of Myiol., 3:179.
- 1939 Townsend, Man. of Myiol., 8: 92-93.
- 1940 Vimmer, Cas. Ceske Spol. Ent. 37(3-4): 101.
- 1942 Townsend, Man. of Myiol., 12: 249, 250, 252, 253, & 460.
- 1947 Curran, Bull. Amer. Mus. Nat. Hist., 89(2): 86.

Generic Description

The following generic description is a modification of Townsend's description (1939, pages 92 and 93). Townsend's extensive use of abbreviations for terminology is considered a most undesirable practice.

Length 13.5 to 19 mm. Very stout, thorax blackish on disk.

Head one-third wider than high; flat frontal profile well sloped and as long as facial; no facial carina; epistoma less than one-half clypeal length and heavily warped; haustellum .87 to .90 eye height; palpi either a little shorter or longer than haustellum and very widely spatulate on over terminal one-half but gradually narrowed basally; antennal axis above eye middle; first antennal segment elongate, second antennal segment long, third antennal segment as long as second with toe directed obliquely forward and below; arista micropubescent;

vertex about 0.30 head width in male and about 0.33 in female; two or three frontal bristles below base of antennae; outer vertical bristles present; inner vertical bristles strongly decussate; two proclinate fronto-orbital bristles in female, absent in male; parafacialia narrow and set with long black hairs; cheeks about 0.34 eye height; genoorbital bristles present; eyes bare.

Thorax with prosternum bare; propleura haired; three preacrostichal bristles; three postacrostichal bristles; four postsutural dorsocentral bristles; two postintraalar bristles; three postsupraalar bristles; three postalar bristles; typically three sternopleural bristles (may vary from two to six); two very long pteropleural bristles; two lateral scutellar bristles and heavy spines, besides preapical and discal spines; infrascutellum well developed; scutellum hairy beneath apical margin; wings infusate, with venation as illustrated in Figure 9; squamae large; tympanic ridge and pit bare; postalar wall bare; legs moderately long; female front tarsal joints two to four greatly widened, male tarsi normal.

Abdomen flattened, heavy subquadrate and much wider than thorax with emarginate tip; tergites three and four bearing marginal row of bristles centrally sinuate into disk with posterior enclosure spined, fifth tergite spined except for front margin; second tergite with two pairs of spiracular openings on ventral mesal edges; tergites three to five each with one pair of spiracular openings on ventral mesal edges; sternites fully exposed; male sternites two to four spined, female sternites two to five spined.

Male hypopygium ventrocaudal; anal forceps chitinized and rigid, sinuate in profile and terminal half slender with ventrally hooked double tip; slender tenth sternite-lobes a little longer than forceps and bowed forward on middle, mesally concave at tip; anterior gonapophyses double tipped and longer than posterior pair; phallus short, stout.

Geographical Distribution. The genus *Paradejeania* occurs in northern South America, Central America, and northward into the south-western and western United States. *Paradejeania* is found in mountainous areas at middle altitudes from Colombia to the southwestern United States, and middle and low altitudes in the western United States. In Central California in the San Francisco Bay area, specimens of *nigrescens* collected at the base of the Jasper Ridge area, back of Stanford University, were collected at an altitude of only 300 feet.

Flowers Visited. The flowers of seven genera of plants, belonging to three families, are known to be visited by *Paradejeania*. This consists of five genera of the family Compositae—*Baccharis* L. (*pilularis* DC.), *Chrysanthemum* Nutt. (*sp.* and *nauseosus* (Pall.) Britt. var *bernardinus* Hall.), *Lepidospartum* Gray (*squamatum* Gray), *Senecio* L. (*douglasii* DC.), and *Rudbeckia* L.; the genus *Rhus* L. of the family Anacardiaceae; and the genus *Melilotus* Juss. of the family Leguminosae. The flower-visiting habit of *Paradejeania* affords the easiest method for their collection, and it may be presumed that the greater part of the specimens in our collections were collected at flowers. The above records all refer to the *Paradejeania rutilioides* subspecies.

Hosts. The hosts of *Paradejeania* are at present unknown. Townsend states (1936, page 117) that the known hosts of the tribe Dejeaniini, which includes *Paradejeania*, "are evidently mainly heterocerous caterpillars." Essig (1915, page 330) states that caterpillars of various species are the hosts, but no specific names are given or available. Townsend's extensive generic host catalog (1942, pages 211-246) makes no mention of any recorded hosts of *Paradejeania*.

Placement of the Genus *Paradejeania*. This genus is placed according to Townsend's scheme of classification, as proposed in his "Manual of Myiology", as one of the 38 genera of the tribe Dejeaniini. The tribe Dejeaniini is in turn one

of the 19 tribes in his "limited" family Tachinidae. *Paradejeania* in Mesnil's classification, as proposed in his "Essai sur les Tachinaires," would fall in the subfamily Larvaevorinae, tribe Larvaevorini, subtribe Larvaevorina.

Key to the Species of *Paradejeania*

1. Abdomen yellow or in part yellow and black, fourth sternite with two rows of macrochaetae, squamae and squamulae yellowish (Nearctic and Central America) 2
- Abdomen rufocastaneous, fourth sternite with but one row of macrochaetae, squamae and squamulae blackish (Colombia) *colombiae* new species.
2. Fifth abdominal tergite blackish, abdomen with a median black vitta *rutilioides nigrescens* new subspecies.
- Fifth tergite mainly yellowish, no continuous median black vitta *rutilioides rutilioides* (Jaennicke).

Paradejeania rutilioides (Jaennicke)

Abdomen yellow with median black spots or yellow with black fifth tergite and median black vitta; head black and brown; thorax black and yellow; legs black and brown. Length 13.5 mm. to 19 mm.; abdomen 8 mm. to 12 mm. in width, wing length 12.5 mm. to 19 mm.

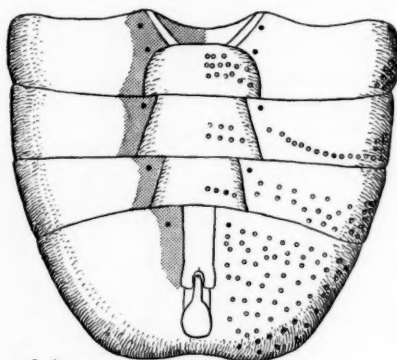
Male: Head black and brown; front at vertex 0.28 to 0.31 of head width; hairs and bristles black except long white postgenal hairs; ocellar triangle black, haired; front reddish-brown and black; frontalia reddish-brown in color, silvery when viewed cephalically; parafrontalia black, silvery laterally when viewed cephalically; parafacials at narrowest point (above vibrissae) 0.09 of head width, at widest point (at base of antennae) 0.18 of head width, silvery except for upper black part which bears the lower frontal bristles; cheeks silvery, with a brownish ground color, long haired; clypeus silvery, light black in ground color; facialia brownish-yellow, with small black hairs; three or four small bristles above vibrissae. Antennae black with silvery tinge; base of third antennal segment and apex of second antennal segment very narrowly rufose. First arisal segment a little longer than wide; second segment twice as long as wide, narrower at base than at apex; ultimate segment about one and one-third as long as third antennal segment, thickened for its basal two-thirds. Palpi about 0.84 eye height; yellow-brown in ground color, silvery at certain angles; basal third narrowed, terminal two-thirds spatulate (compressed laterally); black setulae on outer side, upper outer terminal half much closer setulose than lower half, inner side without setulae except for terminal inner edge. Haustellum about 0.89 eye height, blackish brown; labella short yellow haired.

Thorax black haired; black on disk except for apical fourth to third and lateral margins of postcutum and entire scutellum which are yellow; infrascutellum darkish with silvery tinge; blackish disk with very faint indication of a light vitta near lateral edges of postscutum; pleural areas variously colored—yellow, yellow-brown, to light black, the black areas with silvery tinge, mostly haired; sternopleurae haired only about sternopleural bristles. Wings infuscate (brownish) with venation approximately as illustrated in Figure 9, veins brown. Squamae and squamulae yellowish, edged with yellowish hairs with exception of longer darker hairs at point of outer foldings of squamae and squamulae. Halteres light yellow at base shading darker to brown at apex. Legs black and brown, amount of black and brown varying on coxa, trochanter, femur, and tibia; tarsi blackish; claws black apically and brown basally; pulvilli off-white to light yellow-brown; empodium reddish-brown at base.

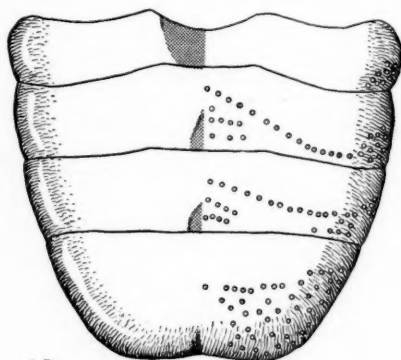
Abdomen bristles as diagnosed in generic description and as illustrated in Figures 2 and 3; bristles and macrochaetae black; abdomen long black haired over entire surface; yellow with median black spots or yellow with fifth tergite black and median black vitta; sternites haired; first sternite without macrochaetae; second sternite with three rows of macrochaetae; third and fourth sternites

each with two rows of macrochaetae; fifth sternite yellowish-brown, the lobes haired while the basal two-thirds devoid of hair.

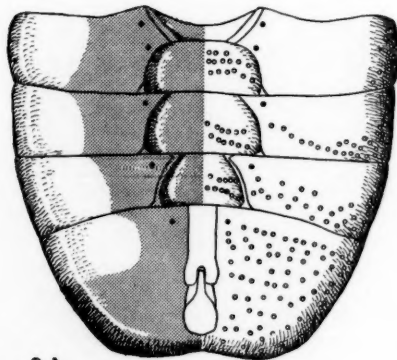
Male genitalia as figured in Figures 5 to 8; anal forceps black, basal two-thirds with long black-brown hair, some of the hair as long as or longer than the



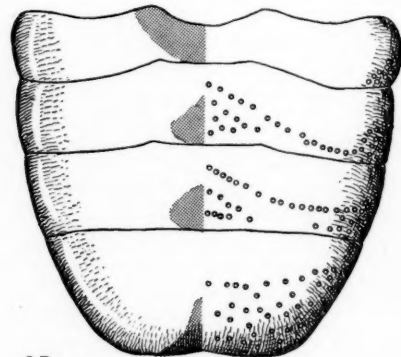
1 A.



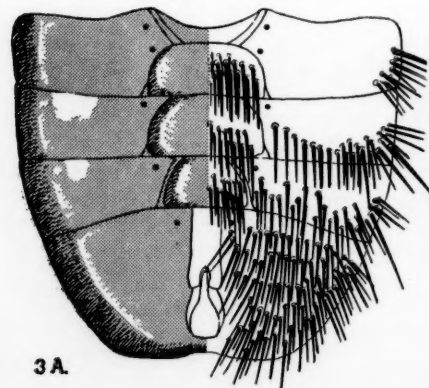
1 B.



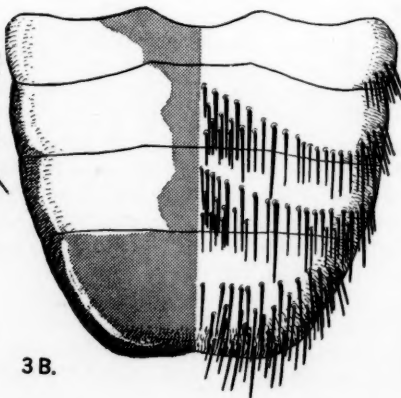
2 A.



2 B.



3 A.



3 B.

length of the anal forceps; tenth sternite lobes brownish-black; apical two-fifths of the ninth tergite shining yellow-brown, devoid of hair, while the basal three-fifths shining brown and haired. The so-called tenth sternite lobes appear to be but projections of the the ninth tergite, for basally the tenth sternite lobes are fused with the ninth tergite.

Female: Agrees with description of the male with the following exceptions: front at vertex approximately 0.33 of head width; two pairs of fronto-orbital bristles; parafacials at narrowest point (above vibrissae) 0.09 of head width, at widest point (at base of antennae) 0.165 of head width; prothoracic tibia two to four greatly widened; fifth sternite with two rows of macrochaetae in addition to hairs; genitalia blackish-brown.

The internal structure of *Paradejeania rutilioides* has been studied and briefly characterized by Townsend (1939, page 93), and he is quoted as follows:

"Ventriculus less than 4 times length of rectal pouch, malpighian ducts as long as latter, colon nearly 6 times rectal pouch, 4 rectal papillae."

"Testes suboval with filiform nipple as long as testis body, vasa efferentia twice length of latter; vehicular glands ellipsoidal, over twice as long as wide, joined side by side to each other and to head of vas deferens; latter 3 times length of glands and inflated on head $\frac{1}{2}$ to size of latter, ejaculatory apodeme Y-like. Spermathecal ducts little longer than spermathecae, uterus with eggs and maggots up to 18 rows."

A description of the first instar larva is given further in the text after the description of the adult of *nigrescens*.

This species is divisible into two subspecies which are indicated below.

***Paradejeania rutilioides rutilioides* (Jaennicke)**

- 1867 *Dejeania rutilioides* Jaennicke, Abh. Senckenbergischen Nat. Ges., 6: 394-395.
- 1867 *Dejeania rutilioides* Jaennicke, Neue Exotische Dipteren aus den Museen zu Frankfurt a.M. und Darmstadt, 86-87. A REPRINT¹
- 1877 *Dejeania rutilioides*, Osten Sacken, Bull. U. S. Geol. Geog. Surv. Terr., 3(2): 354.
- 1878 *Dejeania rutilioides*, Osten Sacken, Smithsonian. Misc. Coll., 270: 147 & 256.
- 1883 *Dejeania rutilioides*, van der Wulp, Tijdschr. Ent., 26: 17.
- 1886 *Dejeania rutilioides*, Williston, Trans. Amer. Ent. Soc., 13: 297.
- 1888 *Dejeania rutilioides*, van der Wulp, Biologia Centr. Amer., Dipt., 2: 9, figs. 3 & 3a on Plate 1.
- 1891 *Dejeania rutilioides*, Brauer & Bergenstamm, Denkschr. Ak. Wiss., 58: 409 & 439.
- 1892 *Dejeania rutilioides*, Townsend, Trans. Amer. Ent. Soc., 19: 88.
- 1893 *Jurinia* (*Paradejeania*) *rutilioides*, Brauer & Bergenstamm, Denkschr. Ak. Wiss., 60: 147 & 184.
- 1897 *Paradejeania rutilioides*, Coquillett, U.S. Dept. Agric. Tech. Ser. No. 7: 146.
- 1897 *Dejeania rutilioides*, Townsend, Ann. Mag. Nat. Hist., (6) 19: 139 & 144.
- 1903 *Dejeania rutilioides*, van der Wulp, Biologia Centr. Amer., Dipt., 2 Supplement: 459.
- 1904 *Paradejeania rutilioides*, Snow, Kan. Univ. Sci. Bull., 12(12): 345.
- 1905 *Paradejeania rutilioides*, Aldrich, Smithsonian. Misc. Coll., 1444: 493.
- 1907 *Paradejeania rutilioides*, Tucker, Kans. Univ. Sci. Bull., 14(2): 101.
- 1908 *Paradejeania rutilioides*, Townsend, Smithsonian. Misc. Coll., 1803: 112 & 113.
- 1915 *Paradejeania rutilioides*, Aldrich, Ann. Ent. Soc. Amer., 8: 80.

¹This issue, which is considered to be a reprint, not only has different pagination and plate numbers, but the title has been lengthened. The original title was merely "Neue Exotische Dipteren."

EXPLANATION TO FIGURES 1 TO 3.

1. *Paradejeania colombiae* n. sp. A. Ventral view of abdomen, right half bristle pattern, left half color pattern; B. Dorsal view of abdomen, right half bristle pattern, left half color pattern.
2. *Paradejeania rutilioides rutilioides* Jaennicke. A. Ventral view of abdomen, right half bristle pattern, left half color pattern; B. Dorsal view of abdomen, right half bristle pattern, left half color pattern.
3. *Paradejeania rutilioides nigrescens* n. subsp. A. Ventral view of abdomen, right half bristle pattern, left half color pattern; B. Dorsal view of abdomen, right half bristle pattern, left half color pattern.

- 1927 *Paradejeania rutilioides* (sic!), Cole, Proc. Calif. Acad. Sci., (4) 16(14): fig. 185 on page 485.
 1928 *Paradejeania rutilioides*, Townsend, Jour. N.Y. Ent. Soc., 36(1): 88.
 1929 *Paradejeania rutilioides* (sic!), Showalter, Nation. Geog. Mag., 56(1): 7, fig. 5 on Plate 14.
 1930 *Paradejeania rutilioides* (sic!), Rowe, Ent. News, 41(9): 305.
 1939 *Paradejeania rutilioides*, Knowlton, Harmston, and Staines, Utah Agric. Exper. Sta., Mimeo. Ser. 200 (Tech.), 5: 15.
 1942 *Paradejeania rutilioides*, Townsend, Man. of Myiol., 12: figs. 244A, 300, 385 & 460.
 1947 *Paradejeania rutilioides* (sic!), Curran, Bull. Amer. Mus. Nat. Hist., 89(2): 86, figs. 76, 80, & 81 on page 114.

This subspecies is characterized by having the dorsal aspect of the abdomen almost entirely yellow except for the mid-dorsal black spots and a lesser apical darkening, as illustrated in Figure 2B. Genitalia as figured for *rutilioides nigrescens* in Figures 5 to 8. *Rutilioides rutilioides* is the larger subspecies and shows the greatest variance in size. Specimens from the Chiricahua Mountains, Arizona, were among the largest examined—with females ranging up to 19 mm. in length, with the abdomen 12 mm. in width, and with a wing length of 17 mm.; and two males 18 mm. in length, with the abdomen 10 mm. in width, and with a wing length of 17 mm. In contrast the smallest *rutilioides* examined was 15 mm. in length, with the abdomen 8.5 mm. in width, and with a wing length of 12.5 mm.

Geographical Distribution. This subspecies has been recorded from Costa Rica northward through Mexico into Texas, New Mexico, Colorado, Arizona, and Utah. The distribution of specimens examined—from south to north—is as follows:

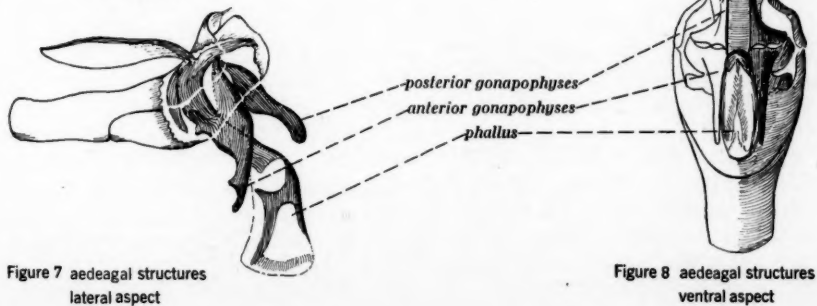
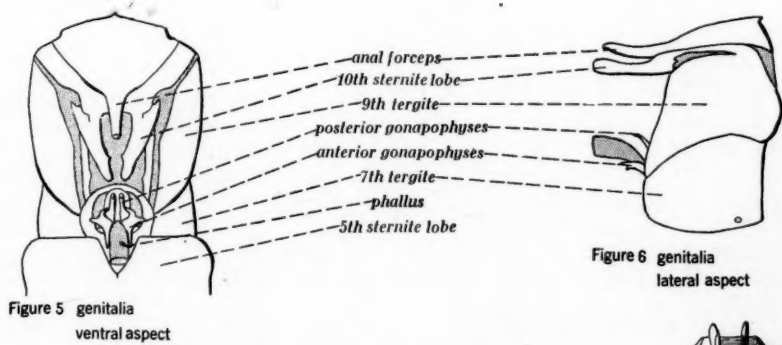
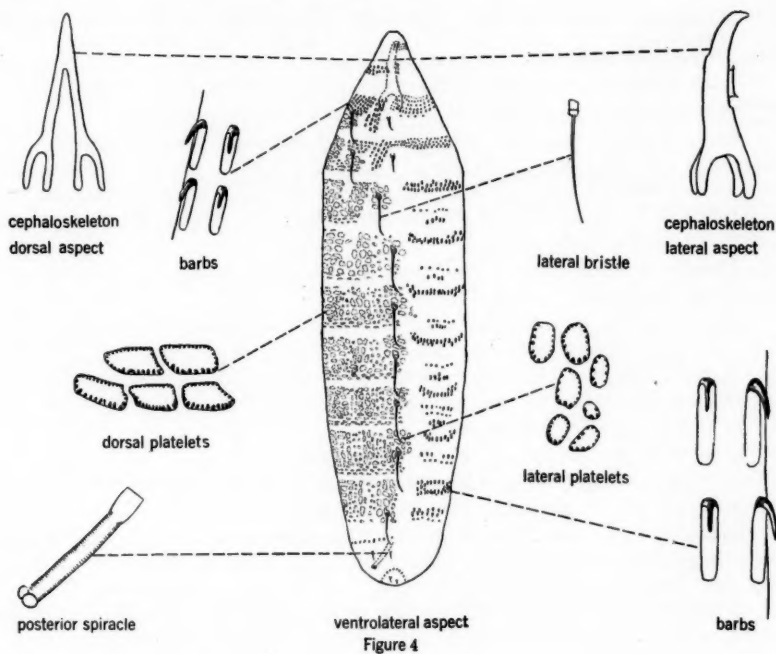
MEXICO: State of Morelos: 1 ♀, Cuernavaca, XI.05 (USNM). State of Mexico: 1 ♂, Amecameca, VIII.00 (O. W. Barrett) (USNM). Distrito Federal: 1 ♀, Mexico City (J. Muller) (USNM). State of Chihuahua: 1 ♀, Soldiers Canyon, 18.VIII.09 (C. H. T. Townsend) (USNM). TEXAS: Brewster Co.: 1 ♂, Chisos Mts., VI.31 (HJR). El Paso Co.: 1 ♀, El Paso, 28.VI.21 (C. D. Duncan) (CAS). NEW MEXICO: Torrance Co.: 2 ♀ ♀, Hell Canyon, Manzano National Forest, 14.IX.16 (C. H. T. Townsend) (USNM). ARIZONA: Cochise Co.: 2 ♂ ♂, 4 ♀ ♀, Chiricahua Mts., Tex. Canyon, 13.IX.27 (J. A. Kusche) (CAS). Pima Co.: 1 ♀, Santa Rita Mts., 5.X.36 (Bryant) (CAS). Gila Co.: 1 ♂, 1 ♀, 29.IX.43 (J. N. Roney) (HJR). Coconino Co.: 1 ♀, Flagstaff, 21.VIII.39 (E. C. VanDyke) (CAS); 1 ♂, Williams, 5.VIII.49 (C. H. Martin) (OSC). COLORADO: El Paso Co.: 1 ♂, Col. Springs, VIII (E. S. Tucker) (SU); 1 ♂, Manitou 20.VIII (F. Marlatt) (HJR). County Unknown: 1 ♂, Rock Creek, 11.VII.37 (G. P. Englehardt) (HJR). UTAH: San Juan-Grand Co.'s: 1 ♂, Miners Basin, La Sal Mts., 23.VII.38 (G. F. Knowlton, F. C. Harmston) (USAC). Grand Co.: 2 ♀ ♀, Moab, 8.IX.47 (T. Tibbetts) (USAC). Washington Co.: 1 ♂, Hurricane, 13.X.38 (G. F. Knowlton, F. C. Harmston) (USAC); 2 ♀ ♀, Rockville, 13.X.38 (G. F. Knowlton, F. C. Harmston) (USAC) & (HJR).

***Paradejeania rutilioides nigrescens* new subspecies**

- 1877 *Dejeania rutilioides*, Osten Sacken, Bull. U. S. Geol. Geog. Surv. Terr., 3(2): 354. (In part.)
 1895 *Dejeania rutilioides*, Townsend, Proc. Calif. Acad. Sci., (2) 4: 618.
 1897 *Paradejeania rutilioides*, Coquillett, U.S. Dept. Agric. Tech. Ser. No. 7: 146. (In part.)
 1913 *Paradejeania rutilioides*, Essig, Monthly Bull. State Comm. Hort., Calif., 2(1-2): 261, fig. 260.
 1913 *Paradejeania rutilioides* (sic!), Woodworth, Guide to Calif. Ins., 142.

EXPLANATION OF FIGURES 4 TO 8.

4. *Paradejeania rutilioides nigrescens*. Ventrolateral aspect and details of first instar larva.
 5. to 8. *Paradejeania rutilioides nigrescens*. Genital and aedeagal structures, lateral and ventral aspects.



1915 *Paradejeania rutilioides*, Essig, Supplement, Monthly Bull. State Comm. Hort., Calif., 330, fig. 324.

1926 *Paradejeania rutilioides*, Essig, Ins. Western N. A., 585 fig. 472. (In part.)

This subspecies can be differentiated from *rutilioides rutilioides* by the difference in abdominal coloration. It is also a smaller subspecies.

Male: Length 14 to 16 mm. Agrees with the description given for *P. rutilioides*, but characterized by having the fifth abdominal tergite black and tergites two to four with a median black vitta about one-sixth of the abdominal width as illustrated in Figure 3B. Sternopleural variation as discussed below. Genitalia as figured in Figures 5 to 8.

Female: Length 13.5 to 16.5 mm. Agrees with description of male except for sexual difference.

Nigrescens is a constantly smaller form. The largest specimens examined were 16.5 mm. in length in contrast with the specimens of *rutilioides rutilioides* that attain a length of 19 mm. In some specimens of *nigrescens* there is a basal band of the fourth tergite that is blackish in coloration.

First Instar Larva: Figure 4.

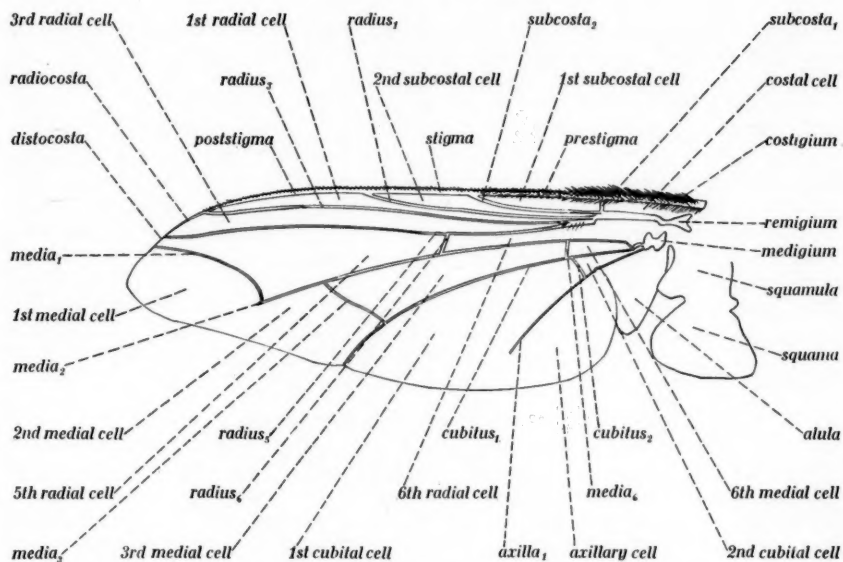
1942 Townsend, Man. of Myiol., 12: figs. 244A, 300 & 385.

Length 0.7 mm. (when cleared in KOH), dorsal and ventral integument composed of dotted platelets, with a lateral row of bristles.

Platelets dotted only on margins. The platelets are more heavily dotted (with larger dots) on their posterior edges. The dorsal platelets are wider than long and the lateral platelets are usually a little longer than wide. There is a lateral row of nine bristles with one on each side on each of segments three to eleven, with an additional smaller lateral bristle on each of segments three and four. The ventral integument has rows of barbs. Cephaloskeleton when viewed laterally slightly bowed in hypostomal region, no dorsopharyngeal process, labial sclerite rather tapering and bent hooklike at tip. Cephaloskeleton when viewed dorsally has a "wishbone" appearance. The posterior spiracles each possess two external openings.

Holotype: ♂, Skyline Blvd., nr. Skylonda, CALIF., San Mateo Co., 21.X.48 (P. H. Arnaud), collected from blossoms of *Baccharis pilularis*. Allotype: ♀, Los Gatos, CALIF., Santa Clara Co., 26.XI.48 (John Lloyd), collected from blossoms of *Baccharis pilularis*. Holotype deposited in the collection of the Department of Entomology, California Academy of Sciences. Allotype in collection of writer. Paratypes: 129 specimens, 71 ♂♂, 58 ♀♀. Paratypes of *nigrescens* have been designated from the following localities in California, Oregon and British Columbia. Distribution is divided into counties—from south to north.

CALIFORNIA: San Diego Co.: 5 ♂♂, 1 ♀, Laguna Mt., 23 & 24.VIII.24 (E. P. VanDuzee) (CAS); 1 ♂, Laguna Mt., 24.VIII.24 (J. O. Martin) (CAS); 1 ♀, San Ignacio, 7.X.46 (R. P. Allen) (CBES). Riverside Co.: 1 ♀, Palm Springs, 7.XI.41 (H. Madsen) (UC); 1 ♀, Palm Springs, 5.XI.32 (C. M. Dammers) (USNM). San Bernardino Co.: 2 ♂♂, Forest Home, 9.IX.28 (W. H. Thorpe) (CESR); 2 ♀♀, Forest Home, 26.X.36 (I. McCracken) (CAS); 11 ♂♂, 9 ♀♀, Mill Creek Canyon, 21 to 24.IX.23 (E. P. VanDuzee) (CAS); 8 ♂♂, 1 ♀, Mill Creek, 8.IX.40, 19.IX.37, 27.IX.36, 3.X.37, 6.X.43 (Timberlake) (CESR); 1 ♀, Mill Creek, 11.X.36 (I. McCracken) (CESR); 2 ♀♀, San Antonio Canyon, 22.X.27 & X.31 (T. Craig) (CAS); 1 ♀, Fern Canyon, XII.25 (T. Craig) (CAS); 2 ♂♂, Seven Oaks, VII.36 (W. C. Reeves) (CAS). Los Angeles Co.: 6 ♂♂, Mts. near Claremont (Baker) (SU); 2 ♂♂, Voltaire, 5.IX.23 (J. D. Gunder) (CAS); 1 ♀, Wrightwood, 15.X, XI.39 (C. Dammers) (CESR). Monterey Co.: 2 ♀♀, Paraiso Springs, 28 & 30.IX.22 (L. S. Slevin) (CAS). Madera Co.:



EXPLANATION OF FIGURE 9.

9. *Parajeania rutiloides nigrescens*. Wing, left dorsal view. Labeled according to Townsend terminology.

2♂♂, Bass Lake, 31.VIII.34 & 2.X.34 (UC). Santa Cruz Co.: 1♀, Santa Cruz Mts., X.34 (J. Applegarth) (SJSC); 1♀, VIII, (USNM). Santa Clara Co.: 1♂, Alma, 2.IX.33 (Keifer) (CBES); 1♂, Alum Rock Canyon, 9.X.40 (K. Frick) (UC); 15♀♀, Los Gatos, 26.XI.48 (J. Lloyd) (PHA); 1♀, 5 miles S.W. of Los Gatos, 4.XI.48 (J. Lloyd) (PHA); 1♀, San Jose, 29.X.07 (USNM); 2♂♂, 7♀♀, Stanford Univ., 25 to 28.X.05 & X.07 (J. M. Aldrich) (USNM) and (UI). San Mateo Co.: 5♂♂, Jasper Ridge, 6 & 11.X.49 (Arnaud) (PHA); 1♂, King's Mtn., 28.IX.41 (UC); 1♂, King's Mtn., 8.X.48 (P. D. Hurd) (UC); 6♂♂, 1♀, Skyline Blvd., nr. La Honda Rd., 7 & 10.X.49 (Arnaud) (PHA). Contra Costa Co.: 1♂, Orinda, 16.X.49 (E. W. Clark) (UC). Sonoma Co.: 2♀♀, S. Sonoma Co., 1.XI & 24.XII.10 (J. A. Kusche) (CAS); 1♂, (USNM). Marin Co.: 1♀, Fairfax, 15.X.11 (E. C. VanDyke); 1♀, San Anselmo, 21.X.39 (M. L. Laymon); both (CAS). Lake Co.: 1♂, Cobb Mtn., 31.VIII.32 (C. D. Duncan) (SJSC). Eldorado Co.: 1♀, Fallen Leaf Lake, 21.VI.42 (H. Madsen) (UC). Trinity Co.: 1♂, 28.IX.17 (E. R. Leach) (SU).

OREGON: Curry Co.: 1♂, Bear Wallow L.D., 10 mi. e. Brookings, VII-IX.40 (A. F. Yeater) (OSC). Coos Co.: 1♂, Myrtle Creek, (OSC). Douglas Co.: 7♂♂, 2♀♀, Riddle, 16-18.IX & 21.IX.38 (S. C. Jones) (OSC); 1♀, Roseburg, 28.IX.26 (D. E. Evans) (OSC). County Unknown: 1♂, Coe's Valley, 30.VIII.29 (R. E. Dimick) (PHA).

BRITISH COLUMBIA: 1♂, Vancouver Island, VII.34 (CAS).²

Sternopleural bristle variation. As has been shown by recent workers certain of the bristle systems of the Dejeaniini may show considerable variation. Sabrosky (1947) in his review of the genus *Eudejeania* records the great vari-

²Paratypes from the writer's collection have been distributed to the following institutional and private collections: American Museum of Natural History, British Museum (Natural History), Mr. A. R. Brooks, Mr. Raul Cortes, Mon. L. P. Mesnil, Museum of Comparative Zoology, Prof. H. J. Reinhard, United States National Museum, and Utah State Agricultural College.

ability of certain of the bristle systems, i.e. proclinate fronto-orbitals, acrostichals, and dorsocentrals. A limited study of the sternopleural bristle variation of *Paradejeania rutilioides* was undertaken. The character of three sternopleural bristles was used by Townsend (1936, p. 179) as a key character. This number was used in comparison with the alternate choice of but one or two sternopleurals for the separation of *Paradejeania* from related genera. In the *Paradejeania rutilioides* subspecies the sternopleural bristles may vary from two to six. Of twenty-one specimens of *rutilioides rutilioides* examined, eleven specimens were typical with a 3:3 (right:left) sternopleural combination. Ten specimens were atypical with either four or five sternopleurals. Only two of the ten atypical specimens did not have at least one set of three sternopleurals. Of fifty-three specimens of *rutilioides nigrescens* examined, thirty-three specimens were typical with a 3:3 sternopleural combination. Twenty specimens were atypical with either two, four, five, or six sternopleurals. Nine of the twenty atypical specimens did not have one set of three sternopleurals.

***Paradejeania colombiae*, new species**

Abdomen rufocastaneous; head black with silvery tinge; prescutum and postscutum black; scutellum castaneous; legs black. Length 16 mm.; abdomen 9.5 mm. at widest point; wing length 15 mm.

Male: Agrees with generic description and characterized as follows. Head black with silvery tinge front at vertex 0.31 of head width; hairs and bristles black except long white postgenal hairs; ocellar triangle long haired, hairs curved forward terminally; frontalia silvery when viewed cephalically; parafrontalia long haired; parafacials at narrowest point (above vibrissae) 0.075 of head width, at widest point (at base of antennae) 0.165 of head width, principally black centered with brown lateral margins, very faintly silvery; cheeks long haired, faintly silvery; facialia faintly silvery tinged, two or three bristles above vibrissae. Antennae black except for brown apical edge of first segment. Arista black, micropubescent; first arisal segment a little wider than long second arisal segment about three times the length of the first, even in width; ultimate arisal segment about one-third times as long as third antennal segment, thickened basal two-thirds. Palpi 0.95 eye height, black, silvery under certain lights, upper outer terminal half much closer setulose than lower half. Haustellum 0.88 eye height, black. Labella short yellow haired.

Thorax long black haired; black except for apical edge of postscutum and entire scutellum which are castaneous; only two developed preacrostichal bristles and four postsutural bristles (four on right, three on left); pleural areas black, with silvery tinge. Wings infusate (light blackish) with venation approximately as illustrated in Figure 9, with some veins black at base, otherwise brown except costa; costa from subcosta 1 to apex black. Squamae and squamulae black, edged with dark colored hairs. Halteres light brown at base gradually shading to brown at apex. Legs entirely black except for brown apical edges of coxae; claws black apically and brown basally; pulvilli mostly smoky brown; empodium reddish brown at base.

Abdomen bristled as diagnosed in generic description and as illustrated in Figure 1; bristles and macrochaetae black; long black haired over entire surface; rufocastaneous³; dorsally spotted very sparsely with black medially—on the concave area of tergite two, and on the apical fourth of tergites three to five; ventrally tergites blackish on mesal border; sternites haired; first sternite without macrochaetae; second sternite with three rows of macrochaetae, the basal row shortest; third sternite with two rows of macrochaetae; fourth sternite with

³According to the color key of Maerz and Paul, the abdominal color seems to match closest on Plate 7, Columns 6-J, defined as "Garnet plus, and also known as Spanish wine and Pigeon blood".

one row of macrochaetae; fifth sternite basally yellow, darkening apically to the brownish lobes, the lobes haired while the basal two-thirds devoid of hair.

Male genitalia with the anal forceps, tenth sternite lobes and the ninth tergite appearing to be of the same shape and general proportions as in *rutilioides*. Anal forceps black, basal two-thirds with long blackish-brown hair, some of the hairs as long or longer than the length of the anal forceps; tenth sternite lobes blackish-brown; apical two-fifths of ninth tergite shining reddish-brown, devoid of hair, while the basal three-fifths shining reddish-brown and haired.

Female: Unknown.

Holotype: Male, "Rio Pomeca⁴, 2500-2600 m., Colombia, 21.VII.1948, L. Richter coll., Frank Johnson donor." Holotype in the collection of the American Museum of Natural History, New York City.

Colombiae is readily separated from *P. rutilioides* by its rufocastaneous abdominal coloration, black squamae and squamulae, and blackish infuscated wings.

Species Referred to *Paradejeania* but Transferred Elsewhere

***Jurinia myrrhea* Brauer & Bergenstamm**

1889 *Jurinia myrrhea* Wiedemann, Brauer & Bergenstamm, Denkschr. Ak. Wiss., 56: 179, and fig. 234 on Plate 9.

1891 *Jurinea* (sic!) *myrrhea* Say, Brauer & Bergenstamm, Denkschr. Ak. Wiss., 58: 409 & 439.

1893 *Jurinia* (*Paradejeania*) *myrrhea* Say, Brauer & Bergenstamm, Denkschr. Ak. Wiss., 60: 184 & 223.

1905 *Jurinia* "*myrrhea* Say", Aldrich, Smithson. Misc. Coll., 1444: 494.

1947 *Paradejeania* "*myrrhea* Say", Curran, Bull. Amer. Mus. Nat. Hist., 89(2): 86.

This specific name would be considered a *nomen nudum* were it not for the fact that a lateral figure of the head was published by Brauer and Bergenstamm in 1889. The status of this name will not be discussed here as it has been incorrectly referred to the genus *Paradejeania*.

***Macrojurinia brasiliensis* (Desvoidy)**

1830 *Jurinia brasiliensis* Desvoidy, Essai sur les Myodaires, 35.

1908 *Paradejeania* species, Williston, Man. N. A. Dipt., fig. 21 on page 44.

1916 *Macrojurinia brasiliensis* (Desvoidy), Townsend, Bull. Amer. Mus. Nat. Hist., 35(2): 20.

1934 *Paradejeania* species, Curran, Fam. & Gen. N. A. Dipt., fig. on page 416.

Dr. C. H. Curran informed the writer (*in litt.*) that the species illustrated as *Paradejeania* species by Williston was in reality *Macrojurinia brasiliensis* (Desvoidy). The specimen photographed by Williston is in the collection of the American Museum of Natural History. Townsend, in 1916, made reference to the Williston illustration when he proposed his new genus—*Macrojurinia*.

Acknowledgments

The writer is especially indebted to Prof. G. F. Ferris for his aid and advice during the preparation of this paper. Special thanks are due also to Dr. C. H. Curran, Mr. C. W. Sabrosky, and Prof. H. J. Reinhard. Acknowledgment of aid is extended also to the following either for the loan of specimens in their charge or for various other favors granted in connection with this study: Dr. W. F. Barr, Dr. E. F. Cook, Prof. E. O. Essig, Mrs. R. S. Ferris, Dr. C. P. Hoyt, Dr. E. L. Kessel, Dr. G. F. Knowlton, Mr. H. B. Leech, Mr. J. Lloyd, Dr. E. S. Ross, Mr. V. D. Roth, Prof. G. J. Spencer, and Mr. P. H. Timberlake.

Bibliography

Aldrich, J. M. 1905. A catalogue of North American Diptera (or two-winged flies). *Smithson. Misc. Coll.*, 1444: 1-680.

⁴The type locality—Rio Pomeca—could not be located on maps available to the writer. The writer is indebted to Dr. Leopold Richter, the collector of this specimen, who kindly furnished the following data concerning the type locality: "The Rio Pomeca arises in the Paramo (colder region) between Tunja and Arcabuco (Dept. Boyaca). It is the only river which crosses this region of the Cordillera of Arcabuco, one of the most interesting tracts of country from the biological point of view. The river runs from east to west, into the Rio Suarez. The name of this one changes later (Rio Sogamoso), and it flows into the river Magdalena."

- Aldrich, J. M. 1915. Results of twenty-five years' collecting in the Tachinidae, with notes on some common species. *Ann. Ent. Soc. Amer.*, 8: 79-84.
- Brauer, F. and Bergenstamm, J. E. V. 1889, 1891, 1893. Die Zweiflugler des Kaiserlichen Museums zu Wien. IV, V, VI. Vorarbeiten zu einer monographie des Muscaria Schizometopa (exclusive Anthomyidae). Pars I, II, III. *Denkschr. Ak. Wiss.*, 56: 69-180, 11 plates; 58: 305-446; 60: 89-240.
- Cole, F. R. 1927. A study of the terminal abdominal structures of male Diptera (two-winged flies). *Proc. Calif. Acad. Sci.*, (4) 16(14): 397-499, figs. 1-287.
- Coquillett, D. W. 1897. Revision of the Tachinidae of America north of Mexico. A family of two-winged insects. *U. S. Dept. Agric. Tech. Ser. No. 7*, 1-154.
- Coquillett, D. W. 1910. The type-species of the North American genera of Diptera. *Proc. U. S. Nation. Mus.*, 37(1719): 499-647.
- Curran, C. H. 1934. The Families and Genera of North American Diptera. The Ballou Press, Pages 1-512.
- Curran, C. H. 1947. New and little known American Tachinidae. *Bull. Amer. Mus. Nat. Hist.*, 89(2): 41-122, figs. 1-134.
- Engel, E. O. 1920. Studien uber neotropische Hystriciidae sensu B. et B. (Dipt.). *Zool. Jahrb. Syst.*, 43(1-4): 273-328, figs. A-H, J-Z, A¹, B².
- Essig, E. O. 1913. Injurious and beneficial insects of California. *Monthly Bull. State Comm. Hort., Calif.*, 2(1-2): i-xxxii, 1-367, 321 figs.
- Essig, E. O. 1915. Injurious and beneficial insects of California. (Second edition). *Supplement, Monthly Bull. State Comm. Hort.*, i-lxxxii, 1-541, 503 figs.
- Essig, E. O. 1926. Insects of Western North America. The Macmillan Company, Pages i-xi, 1-1035, 766 figs.
- Jaennicke, F. 1867. Neue Exotische Dipteren. *Abb. Senckenbergischen Nat. Ges.*, 6: 311-408, plates 43 & 44.
- Jaennicke, F. 1867. REPRINT. Neue Exotische Dipteren aus den Museen zu Frankfurt a.M. und Darmstadt, Pages 1-99, plates 1 & 2.
- Macr, A. and M. R. Paul. 1930. A Dictionary of Color. McGraw-Hill Book Company, Inc., Pages i-vii, 1-207, 56 plates.
- Mesnil, L. 1939. Essai sur les Tachinaires (Larvaevoridae). Imprimerie Nationale, Paris, Pages 1-67, i-v with plates I & II.
- Osten Sacken, C. R. 1877. Western Diptera: descriptions of new genera and species of Diptera from the region west of the Mississippi and especially from California. *Bull. U. S. Geol. & Geog. Sur. Terr.*, 3(2): 189-354.
- Osten Sacken, C. R. 1878. Catalogue of the described Diptera of North America. (Second edition). *Smithson. Misc. Coll.*, 270: i-xlvi, 1-276.
- Rowe, J. A. 1930. Distributional list of the tachinid flies from Utah. *Ent. News*, 41(9): 303-305.
- Sabrosky, C. W. 1947. A synopsis of the larvaevorid flies of the genus Eudejeania. *Proc. U. S. Nation. Mus.*, 97(3215): 141-156.
- Showalter, W. J. 1929. Insect rivals of the rainbow. *Nation. Geog. Mag.*, 56(1): 28-90, plates 1-24, figs.
- Snow, F. H. 1904. List of Coleoptera, Lepidoptera, Diptera and Hemiptera collected in Arizona by the entomological expeditions of the University of Kansas in 1902 and 1903. *Kans. Univ. Sci. Bull.*, 12(12): 323-350.
- Townsend, C. H. T. 1892. Notes on North American Tachinidae sens. str. with descriptions of new genera and species. Paper III. *Trans. Amer. Ent. Soc.*, 19: 88-132.
- Townsend, C. H. T. 1895. On the Diptera of Baja California, including some species from adjacent regions. *Proc. Calif. Acad. Sci.*, (2) 4: 593-620.
- Townsend, C. H. T. 1897. Contributions from the New Mexico Biological Station.—No. IV. Diptera from the Sacramento and White Mountains, in Southern New Mexico. I. *Ann. Mag. Nat. Hist.* (6) 19: 138-149.
- Townsend, C. H. T. 1908. The taxonomy of the muscoidean flies, including descriptions of new genera and species. *Smithson. Misc. Coll.*, 1803: 1-138.
- Townsend, C. H. T. 1911. Announcement of further results secured in the study of muscoid flies. *Ann. Ent. Soc. Amer.*, 4(2): 127-152.
- Townsend, C. H. T. 1913. Inquiry into the relationships and taxonomy of the muscoid flies. *Can. Ent.*, 45(2): 37-57.
- Townsend, C. H. T. 1913. On the tribe Dejeaniini of the muscoid family Hystriciidae, with five new genera. *Psyche*, 20(3): 102-106.
- Townsend, C. H. T. 1928. On the rare occurrence of certain American muscoid forms of striking character. *Jour. N. Y. Ent. Soc.* 36(1): 83-93.
- Townsend, C. H. T. 1936, 1939, 1942. Manual of Myiology, 3: 1-255; 8: 1-408; 12: 11-349, plates 7-84.

- Tucker, E. S. 1907. Some results of desultory collecting of insects in Kansas and Colorado. *Kans. Univ. Sci. Bull.* 14(2): 51-108.
- Vimmer, A. 1940. Prehled rodu jihoamerickych Hystriciid. Übersicht der gattungen der sudamerikanischen Hystriciiden (Tachinidae, Dipt.). *Cas. Ceske Spol. Ent.*, 37(3-4): 100-103.
- Wulp, F. M. van der. 1883. Amerikaansche Diptera. *Tijdschr. Ent.* 26: 1-60, plates 1 & 2.
- Wulp, F. M. van der. 1888-1903. Biologia Centrali-Americana. Zoologia. Class Insecta. Order Diptera. 2:1-432, 12 colored plates; 2 Supplement: 435-489, 1 colored plate.
- Williston, S. W. 1886. Dipterological notes and descriptions. *Trans. Amer. Ent. Soc.*, 13: 287-307.
- Williston, S. W. 1908. Manual of North American Diptera. Third Edition. James T. Hathaway, Pages 1-405, 163 figs.
- Woodworth, C. W. 1913. Guide to California Insects. The Law Press, Berkeley, Pages 1-360, 361 figs.

A Rapid Staining Method for Clinical Study of Cockroach Blood Cells¹

By D. S. SARKARIA, SERGIO BETTINI², AND R. L. PATTON

Department of Entomology, Cornell University
Ithaca, N.Y.

In order to expedite the study of the effects of various biologically active chemicals upon the blood cells of insects a rapid clinical type method was needed that would allow preparations to be made with small (1 microliter or less) samples of blood which could be drawn without sacrificing the insect, and could be fixed and stained quickly for examination. A method meeting these requirements for the study of the blood cells of the American and German cockroaches has been developed.

The previous work on insect blood has been directed primarily toward the study of the morphology of the cells and the processes of coagulation. The principal methods include that of Shull (1936) who treated the insects with the vapor of several fatty acids including acetic acid to fix the cells; and the technique of Yeager (1938, 1945) who fixed the blood cells by killing the insect by immersion in water at 50° to 60°C. for a period of 10 minutes. Jones (1950) has used a similar method but has reduced the fixing time to 1 to 2 minutes. In all of the above cases air dried smears were prepared using a standard smearing technique and the cells were stained using a Wright's blood stain or Giemsa stain. None of the above methods meet the requirements which have been set forth since they all require sacrificing the insect for the blood sample and thus preclude the determination of successive changes in the blood picture of an individual. In addition to this, the staining procedures for both Wright's and Giemsa methods require a relatively long period for preparation and are difficult in their technique.

In the process of developing a more satisfactory method several techniques for fixation were tried and abandoned and stains including crystal violet, gentian violet improved (Coleman & Bell), safranin, methyl green, janus green B, neutral red, eosin, methylene blue, Giemsa and Wright's blood stain were used.

The method which gives the best results was adapted from the procedure described by Yeager and Tauber (1933) for the preparation of cells of cockroaches for counting mitotically dividing hemolymph cells. This method prescribed a 0.005% solution of gentian violet in a saline containing the chlorides of sodium,

¹Aided by a grant from the Division of Research Grants National Institutes of Health, Bethesda, Maryland.

²Rockefeller Fellow from the Superior Institute of Health, Rome, Italy.

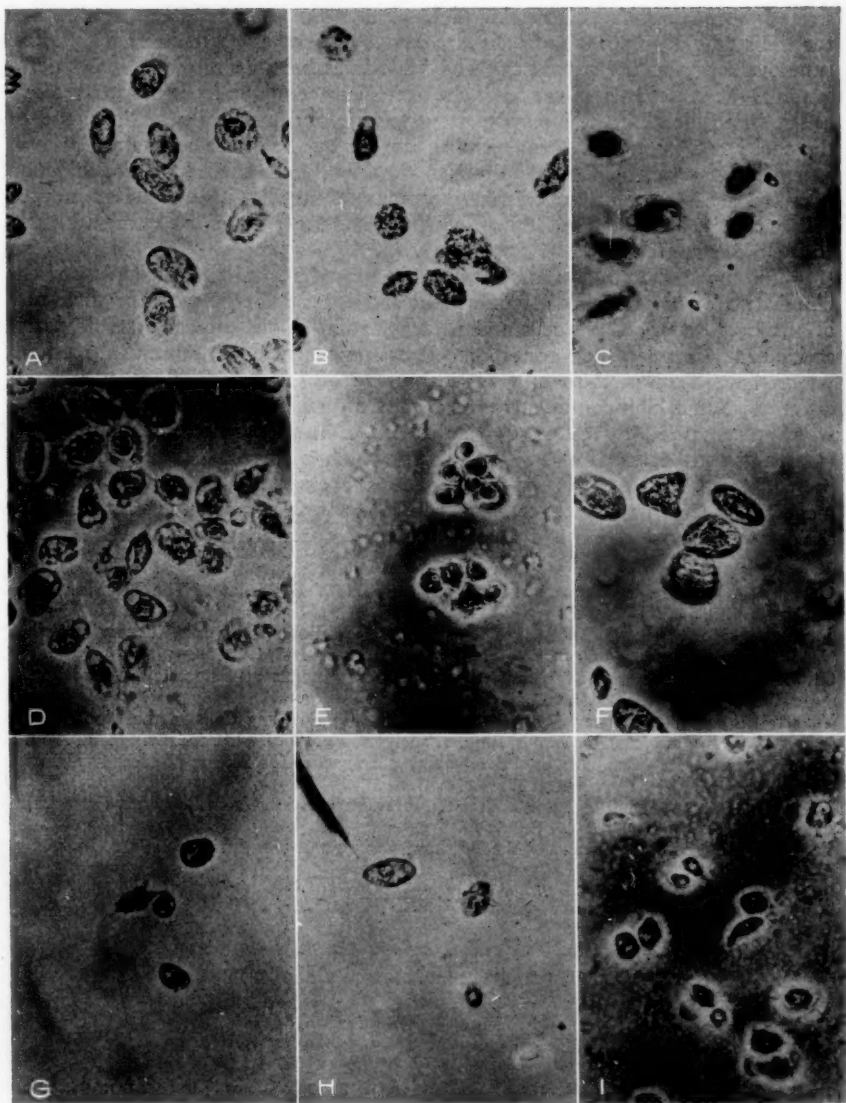
potassium, and calcium. This was acidified to 0.125% with acetic acid. With the procedure which has been developed from this the fixing-staining medium has been prepared by adding the chlorides of sodium, potassium, calcium, and magnesium in the amounts prescribed by Yeager (1939) for a saline isosmotic with the blood of the American cockroach to a 0.5% solution of crystal violet (Cl. No. 681, NC 21). This solution was then acidified to a $\text{pH} = 2.9 \pm 0.1$ with glacial acetic acid (approximately 1%). To prepare 100 ml. of this medium dissolve 0.5 grams of crystal violet in about 95 ml. of distilled water; add 1.09 grams of sodium chloride, 0.157 grams of potassium chloride, 0.085 grams of calcium chloride, and 0.017 grams of magnesium chloride. When the salts are completely dissolved the solution is acidified and the total volume is brought to 100 ml. with distilled water. A filtered solution prepared in this way will remain stable for at least one month. This medium has been used successfully to fix and stain the cells of both American and German cockroaches (Plate I, A and F).

To make a preparation, a drop of the medium is placed upon a microscope cover slip and the blood is introduced directly into it from a cut antenna. The blood is mixed with the medium by stirring with a fine filament of glass, and the preparation is mounted by inverting the cover slip on a microscope slide. The edges may be sealed with petrolatum jelly, and cells mounted in this way will show no changes for several days. Preparations made in this manner are suitable for study at high magnifications including oil immersion.

There are several factors which control the staining and fixing reactions in this method. The pH and concentration of acetic acid combine to control the degree of staining of the cells and the degree of fixation. A lighter or more dense stain can be achieved by lowering or raising the pH respectively. The optimum pH for general use is about 2.9. Stain concentration is also a factor and it is possible to increase the degree of staining by adding more fixing-staining medium to the coverslip preparation before mounting. An important factor which definitely enters into the preservation of the normal cell shape is the tonicity of the medium. This should be within the range which is isosmotic with the normal blood of the insect. This factor and the ionic salt balance are more or less critical and must be determined for each group of insects.

The application of this technique to insects of other orders than Orthoptera has been attempted with promising results. Blood cells from the larva and adults of *Tenebrio molitor*, *Galleria mellonella*, *Prodenia eridania*, and *Oncopeltus fasciatus* have been prepared using media with appropriate osmotic pressures and salt balances. Results with *Tenebrio molitor* have been entirely satisfactory with a medium isosmotic with 2% NaCl; however, with the other forms some cell distortion has been observed which is interpreted to indicate improper osmotic or salt balance.

The photomicrographs shown in Plate I are all at the same magnification (about 600 x) and in A, B, and C they show the results of preparing the cells of the American cockroach by several methods. In A the cells were fixed and stained according to the method described. These have retained their normal elliptical shape and there is no distortion or clumping. The nuclei and their components as well as cytoplasmic inclusions are well differentiated and the cytoplasm is lightly stained. Photomicrograph B shows a similar preparation stained with crystal violet after fixing with the heat treatment recommended by Yeager. In this case the blood was collected in Yeager's physiological saline and crystal violet was added from a 0.5% solution. The results from this treatment are definitely inferior to those shown in A. Photomicrograph C shows the results of a preparation made with an air dried smear of heat fixed cockroach blood



A. Normal blood cells from *P. americana* fixed and stained according to the described procedure; 600 x. B. Heat fixed blood cells from *P. americana* stained with crystal violet; 600 x. C. Heat fixed smear from *P. americana* stained with Wright's Stain; 600 x. D. *P. americana* blood cells blocked with erythrocytes following phagocytic action; 600 x. E. *P. americana* blood cells showing advanced chemical injury; 600 x. F. Normal blood cells from *B. germanica* fixed and stained according to the described procedure; 600 x. G. Normal cells from *T. molitor* larva fixed and stained as described. H. Normal blood cells from *T. molitor* fixed and stained as described. I. Normal blood cells from *G. mellonella* larva fixed and stained as described.

stained with Wright's blood stain. Although this method has been widely used for the study of insect blood cells, the results are not as satisfactory for clinical type evaluation as the simpler method which has been described. Photomicrograph D illustrates an application of the simplified technique to demonstrate blood cell injury following the injection of vertebrate erythrocytes into the blood of the cockroach with the subsequent phagocytosis by the insect cells; and E. shows an advanced case of chemical injury to the blood cells caused by the injection of n-propanol. The cells shown in photomicrographs F, G, H, and I are normal cells from the blood of the German cockroach, *Tenebrio molitor* larva and adult, and *Galleria mellonella* larva respectively.

The technique which has been described for the fixation and staining of the blood cells of cockroaches offers a rapid and dependable method for the study of the cytology of these cells and the evaluation of the effects of biologically active materials upon their condition. It has precedent in the supravital methods which have been used for the clinical study of human blood cells; and the differentiation which can be achieved by use of crystal violet as a stain has been widely recognized by cytologists interested in the study of cell components (Gatenby and Beams, 1950). The method which is described is applicable in its present form to the study of the blood of cockroaches and probably other members of the order Orthoptera. It can be used with other insects by adjusting the osmotic concentration and the salt balance to appropriate levels.

References

- Gatenby, J. B., and H. W. Beams. Lee's Microtome's Vade-Mecum. The Blakiston Company, Philadelphia, Pa., Toronto, Canada. 1950.
- Jones, J. C. The Normal Hemocyte Picture of the Yellow Mealworm, *Tenebrio molitor* Linnaeus. *Iowa State College Journal of Science* 24: 355-361. 1950.
- Shull, W. E. Inhibition of Coagulation in the Blood of Insects by Fatty Acid Vapor Treatment. *Ann. Ent. Soc. Amer.* 29: 341-349. 1936.
- Yeager, J. F., and O. Tauber. On Counting Mitotically Dividing Cells in the Blood of the Cockroach, *Periplaneta orientalis*, Linn. *Proc. Soc. Exp. Biol. and Med.* 20: 861-863. 1933.
- Yeager, J. F. A Modified Wright's Blood-staining Procedure for Smears of Heat-fixed Insect Blood. *Ann. Ent. Soc. Amer.* 31: 9-14. 1938.
- Yeager, J. F. Electrical Stimulation of Isolated Heart Preparations from *Periplaneta americana*. *Jour. Agr. Res.* 59: 121-137. 1939.
- Yeager, J. F. The Blood Picture of the Southern Armyworm (*Prodenia eridania*). *Jour. Agr. Res.* 71: 1-40. 1945.

A Note on Dipterous Predators of the European Red Mite, *Metatetranychus ulmi* (Koch)

By H. R. BOYCE AND E. J. LEROUX

Fruit Insect Laboratory, Division of Entomology, Canada Department of Agriculture
Harrow, Ontario

During the latter part of August and early in September, 1950, dolichopodid flies were observed feeding on adults of the European red mite on apple foliage, untreated with acaricides, in the Science Service orchard, Harrow, Ontario.

Specimens were determined by Mr. J. R. Vockeroth, Systematic Entomology, Division of Entomology, Ottawa, as follows: *Condylostylus sipho* (Say), *Laxina nigrofemoratus* (Wlk.), and *Diaphorus* or *Chrysotus* sp.

According to Curran (1934. The families and genera of North American Diptera, p. 215) species of *Diaphorus*, *Chrysotus*, and *Condylostylus* occur chiefly on foliage and many species are extremely local in habitat.

It appears that this is the first record of these dolichopodids as predators of the European red mite in Canada.

A Field Key to the Species of *Cinara* (Homoptera: Aphididae) of Canada East of the Rockies¹

By G. A. BRADLEY²

Dominion Entomological Laboratory
Indian Head, Saskatchewan

Aphids of the genus *Cinara* found in Canada east of the Rockies are, with few exceptions, large, dark in colour, and compact in form. They live entirely on coniferous hosts and each species is restricted either to a single species of plant, or to plants of the same genus. Their unvarying choice of a host plant makes it possible to separate the species into groups according to the genus of plant on which they occur; this characteristic is used in the following key.

On <i>Pinus</i>	A
On <i>Picea</i>	B
On <i>Abies</i>	C
On <i>Juniperus</i>	D
On <i>Larix</i>	E

A on *Pinus*

- Legs long and slender. First segment of hind tarsus less than one-half length of second segment 2
Legs short and thick. First segment of hind tarsus one-half length or more of second segment 5
- Colour black, with a conspicuous pattern of white secretion. On white pine *C. strobi* (Fitch)
Colour not predominantly black and white. Not on white pine 3
- Dark-brown or bronze in colour, with conspicuous black cornicles. Hind tibiae of alatae uniformly dark. On red pine *C. carolina* Tissot
Hind tibiae of alatae with lighter areas near their bases. Not on red pine 4
- Small aphid with the dorsum of the abdomen black, shiny and mirror-like. On limbs and trunk of jack pine; not on new growth *C. atra* (Gillette and Palmer)
Dorsum of abdomen not black and mirror-like. On the new growth *Cinara* sp.
- Ocular tubercles absent. Hind tibiae entirely dark *C. pergandei* (Wilson)
Ocular tubercles present. Hind tibiae with light areas near base *C. pini* (L.)

B on *Picea*

- Colour light-green. Second tarsal segment exceptionally long and curved *C. fornacula* (Hottes)
Colour dark. Second tarsal segment not unusually long 2
- Body colour dull bluish-black; legs uniformly orange or yellow *C. hottesi* (Gillette and Palmer)
Body colour brown; legs dusky 3
- Large aphids with the hind tibiae exceptionally long and curved. Setae of body and appendages short and sparse *C. colorandensis* (Gillette)
Hind tibiae not conspicuously long. Body and appendages bearing long setae 4
- Colour chocolate-brown to bronze, with a pattern of white secretion *Cinara* sp.

C on *Abies*

- Body and appendages densely clothed with long setae. Dorsum of the abdomen bearing a row of dark markings on either side of the median line *C. lasiocarpae* (Gillette and Palmer)
Body not conspicuously hairy. Abdomen without regular rows of dark markings 2
- Hind tibiae exceptionally long and curved *C. curvipes* (Patch)

D on *Juniperus*

- Small light-brown or rosy aphids with conspicuous brown cornicles. On *Juniperus communis* *C. rubicundus* (Wilson)
Colour dark-grey. On *Juniperus virginiana* *Cinara* sp.

E on *Larix*

- Large dark-brown or bronze-coloured aphids on the twigs, branches, or trunks of larch *C. laricis* (Hartig)

¹Contribution No. 19, Division of Forest Biology, Science Service, Department of Agriculture, Ottawa, Canada.

²Agricultural Research Officer.

***Cinara strobi* (Fitch)**

This was the only species of *Cinara* that was found on white pine. The aphids were often present in large numbers on the branches and upper trunk of the tree. When disturbed, the aphids quickly raise their bodies at an oblique angle to the surface of the tree, so that only the front legs and the mouthparts maintain contact with the bark. In this way the vulnerable abdomen is placed beyond the reach of predators which move about close to the surface of the bark. The body is moved rapidly from side to side while in this position, which may further serve to discourage attack by a predator. The form of the body is long and narrow rather than globose as in many of the other species. The eggs are laid in rows along the needles.

Host: *Pinus strobus*

Locality: Collected from numerous localities in Ontario and Quebec.

***Cinara carolina* Tissot**

These aphids were found in dense colonies on the larger limbs and trunks of small red pines. They are much less active than *C. strobi* and depend upon their great numbers and the early production of winged forms to escape coccinellid and syrphid predators. The eggs are laid in rows on the needles, and are often concentrated on a single small shoot.

Host: *Pinus resinosa*

Locality: Ottawa, Blind River, and Sault Ste. Marie, Ontario.

***Cinara atra* (Gillette and Palmer)**

Aphids of this species are small and shiny-black in colour. They were found in dense colonies usually attended by large numbers of ants. In the spring and early summer the colonies encircled the lateral branches of jack pine, about two feet from the tips. In midsummer they formed irregular patches on the trunk itself. In the fall the colonies were again on the lateral branches, and from them the oviparous females moved out to the tips to lay their eggs. Each egg was laid singly and was inserted between the two needles in the bundle at the point where they began to separate, so that some protection was afforded between the flat inner surfaces of the needles. This oviposition habit is characteristic of the species.

Host: *Pinus banksiana*

Locality: Sault Ste. Marie, Ontario.

***Cinara pergandei* (Wilson)**

These are large, globose aphids living on the twigs and new growth of jack pine. They are solitary in habit and rarely are two individuals found close together, even the young becoming separated from the female immediately after birth. They apparently rely on dispersion for protection against their predators. The large, ovoid, black eggs laid by the oviparous females in the fall occur singly, and each is attached to the centre of a needle.

Host: *Pinus banksiana*; *Pinus mugbus*.

Locality: Collected from numerous localities in Ontario, Manitoba and Saskatchewan.

Synonym: *Cinara longispinosa* Tissot. Florida Ent. 16: 4, 1932.

***Cinara pini* (L.)**

Aphids of this species are large in size and dark-brown in colour. The dorsum of the abdomen is speckled with numerous, small, brown spots. The aphids occur on the twigs and small branches of Scotch pine, and are solitary in habit.

Host: *Pinus sylvestris*.

Locality: Ottawa and St. Catharines, Ontario.

Cinara fornacula (Hottes)

The light-green colour of these aphids and their preference for the new shoots of the host make their identification in the field an easy matter. They occur in small colonies, or as single individuals distributed along the twig, never in compact colonies. In the oviparous female, the tip of the abdomen posterior to the cornicles is covered with a thick, white, powdery material. The eggs are laid on the needles near the tips of the twigs.

Host: *Picea canadensis*.

Locality: Collected from numerous localities in Ontario, Manitoba and Saskatchewan.

Cinara hottesi (Gillette and Palmer)

Aphids of this species are usually found in a dense colony among the needles on the leader of a young spruce and when numerous they cover the upper branches and trunk of the tree. The dull, bluish-black coloration is characteristic and serves to distinguish this species from all the others observed.

Host: *Picea canadensis*.

Locality: Chelsea, P.Q.; Ottawa and Sault Ste. Marie, Ontario; Indian Head, Saskatchewan.

Cinara coloradensis (Gillette)

These are large aphids with an elongate, rather than a compact form. The appendages and especially the hind tibiae, are exceptionally long. The setae of the body and legs are short and inconspicuous. The aphids were found singly, or in small colonies consisting of a female and young nymphs.

Host: *Picea canadensis*.

Locality: Ottawa and Sault Ste. Marie, Ontario; Pine Falls, Man.

Cinara rubicundus (Wilson)

Small inconspicuous aphids found on the lower surfaces of the twigs and branches of common juniper are likely to belong to this species. The body is covered with a powdery secretion which gives it a white coloration tinged with rose. The aphids bear a striking resemblance to the small undeveloped juniper berries found along the stems. The legs, eyes and cornicles are dark-brown, and there are rows of brown markings along the abdomen. The eggs occur singly and each is attached to the centre of the under surface of a needle.

Host: *Juniperus communis*.

Locality: Chelsea, P.Q.; Ottawa and Sault Ste. Marie, Ont.

Cinara laticis (Hartig)

These are large, globose, brown aphids found on tamarack. When numerous they form colonies on the trunk or branches; when only a few are present they are more often found on the new growth near the tips. The large black eggs are laid on the bark of the branches or trunk of the tree.

Host: *Larix laricina*.

Locality: Collected from numerous localities in Quebec, Ontario and Saskatchewan.

A Review of the Nearctic Species of *Lasiopleura* (Diptera, Chloropidae)

By CURTIS W. SABROSKY

Bureau of Entomology and Plant Quarantine, Agricultural Research Administration
United States Department of Agriculture

The genus *Lasiopleura* Becker is peculiar in the family Chloropidae in the unusual development of the chaetotaxy of head and thorax. It is apparently an ancient group, with representatives in all the faunal regions. A number of generic names have been proposed, and a thorough study of the species of the world may show that some of them can be maintained, either as genera or as subgenera, though perhaps on different bases from those on which they were proposed. The group is especially rich in species in Australia and the South Pacific area.

In North America the few species are small and generally inconspicuous, and few examples have been found in thousands of specimens of Chloropidae in collections. A review of this small amount of accumulated material was prompted by the unusual rearing of a series by Dr. H. T. Spieth. This study revealed such consistent, though small, differences that several closely related species appear to be involved in what has previously been regarded as a single species, *Lasiopleura hirta*.

In the most readily available key to American genera of Chloropidae (Curran, 1934, "The Families and Genera of North American Diptera," pp. 341-344), the synonym *Pseudobippelates* Malloch (1913) is used instead of *Lasiopleura* Becker (1910). Unfortunately, over half of the North American species will not key out there because they do not have "a strong, curved ventral spur" at the apex of the hind tibia. In *hirta* and three new species there is a slightly thicker hair in the proper position, which may represent a much reduced "spur", but it would not be recognized as such. In *grisea*, the "spur" is but little longer than the hairs, though distinctly thickened. Only in the *capax* group is the spur strong and curved. The best character for recognizing the genus *Lasiopleura* is the strongly (for a chloropid) bristled appearance, particularly in the development of the humeral, fronto-orbital and presutural bristles. In some species, several pairs of dorsocentral bristles are present.

The interfrontal bristles mentioned in the key and descriptions stand out clearly from the coarse hairs scattered on the front. When two or three pairs are present, they form two rows which flank the triangle and continue anterior to it.

Lasiopleura Becker

Becker, 1910, Archivum Zoologicum 1: 130. Type, by monotypy, *Oscinis longepilosa* Strobl (Europe).

Pseudobippelates Malloch, 1913, Proc. U.S. Natl. Mus. 46: 261. Type, by original designation, *Hippelates capax* Coquillett.

Synonyms from other parts of the world are not cited here.

Costa extending to fourth vein; eyes bare; arista short to long pubescent; chaetotaxy well-developed: inner and outer verticals strong, postverticals erect and cruciate, ocellars proclinate and divergent, several (usually three) long fronto-orbitals proclinate or directed anterolaterad or laterad, two humerals, the upper arched mesad over the mesonotum, notopleurals 1 plus 1, strong presutural, dorsocentrals sometimes well developed; legs slender; "sensory area" on postero-dorsal surface of hind tibia narrow, almost linear, sometimes scarcely visible.

The species can be divided into two groups. In the one (*capax*, *barberi*, *willistoni* and *longula*), there is a distinct hind tibial spur and only one pair

(prescutellar) or dorsocentral bristles, and the posterior notopleural bristle is well removed from the lower margin of the notopleuron and thus on a different level from the anterior bristle. These species also share the distinctive though perhaps not fundamentally significant character of a T-shaped yellow spot on the front formed by an anterior marginal crossband with a short median stripe between it and the apex of the frontal triangle. In the other group, composed of *birta*, *birtoides*, *shewelli* and *itascae*, no spur is developed, there are two to four pairs of dorsocentral bristles, the anterior and posterior notopleural bristles are on the same level, but close to the lower margin of the notopleuron, and the front lacks a T-shaped spot, having only the anterior marginal band of yellow.

Lasiopleura grisea will not be readily associated with either group because of its distinctive habitus, but it seems closer to the *capax* group in such respects as the single pair of dorsocentral bristles and the posterior notopleural bristle well removed from the lower margin of notopleuron. It lacks the T-shaped pattern of yellow on the front, but this hardly seems a fundamental character.

Key to the Nearctic Species of *Lasiopleura*

1. Arista white except for extreme base; cheek broad, fully as wide or wider than breadth of third antennal segment and approximately half the height of an eye, with two or three irregular and scattered rows of pale white hairs scarcely distinguishable against the silvery-white background; vibrissa weak, pale white *L. grisea* Malloch
 Arista black; cheek relatively narrow, obviously narrower than breadth of third antennal segment and 1/7 to 1/3 the eye height; cheek with one or two rows of coarse black hairs and a relatively strong black vibrissa 2
2. Hind tibia with distinct, curved, shining black preapical spur, equal to or slightly longer than diameter of tibia; front with T-shaped pattern of yellow, formed by narrow anterior marginal band plus short median stripe back to apex of frontal triangle 3
 Hind tibia without spur; front with only the yellow anterior marginal band 6
3. Frontal triangle predominantly polished, the sparse pollen confined to ocellar tubercle and extreme apex of triangle; cheek with two rows of coarse black hairs
L. willistoni, n. sp.
 Frontal triangle predominantly pollinose, the polished areas appearing as two irregularly rounded, eye-like spots, one on each side of ocellar tubercle, the spots occasionally reduced to small areas adjacent to posterior ocelli; cheek with single row of coarse black hairs 4
4. Pleuron with only the mesostigmal spot polished (West Indies) *L. longula* (Becker)
 Pleuron with large polished area anteriorly, including mesostigmal spot, the area ventral to it, and anteroventral portion of mesopleuron 5
5. Frontal triangle bright gray, densely pollinose; mesonotum gray pollinose, with distinct median stripe of brown pollen; male genitalia as in Fig. 1 *L. capax* (Coquillett)
 Frontal triangle predominantly polished, with large polished spot on each side of ocellar tubercle, rarely reduced to a small spot laterad of each posterior ocellus; both triangle and mesonotum sparsely pollinose, and hence subshining and dark gray to brownish gray; male genitalia as in Fig. 2 *L. barberi*, n. sp.
6. Pro- and mesopleuron entirely gray pollinose, except for small spot at the anterior spiracle 7
 Pleuron with conspicuous polished areas on pro- and mesopleuron, in addition to polished mesostigmal spot 8
7. Only one pair of strong interfrontal bristles; cheek narrow, 1/7 the height of an eye
L. birta (Loew)
 Two to three pairs of strong interfrontal bristles; cheek broader, averaging nearly 1/3 the eye height
L. birtoides, n. sp.
8. Only one pair of strong interfrontal bristles; cheek narrow, 1/6 to 1/7 the height of an eye; subspiracular polished area separated by a band of pollen from oval mesopleural area *L. itasca*, n. sp.
 Two to three pairs of strong interfrontal bristles; cheek broader, 1/4 to 1/3 the eye height; pleuron with one large polished area, the subspiracular and mesopleural areas confluent *L. shewelli*, n. sp.

***Lasiopleura grisea* Malloch**

Lasiopleura grisea Malloch, 1934, Diptera Patagonia & S. Chile, Pt. VI, Fasc. 5: (Arizona; Guatemala)

A bright gray, densely pollinose species with silvery-gray face and cheeks. The front is colorful, with large and bright gray frontal triangle, anterior two-fifths of front bright yellow, and the posterior corners of front, flanking the apical part of the triangle, shading from a rich maroon to black. The pleuron is entirely and densely gray pollinose, with not even a polished spot at the anterior spiracle. The hind tibial spur is present only as a short straight bristle scarcely longer than the surrounding hairs. The coloration and general habitus are reminiscent of some species of *Pelomyia* (Tethinidae), and specimens may be found confused with material of that genus.

The species was described from Arizona and Guatemala without definitely designated holotype or type locality. A female in the U.S. National Museum from Bill Williams Fork, Arizona, August (F. H. Snow), bears Malloch's label as "type" and a red type label with U.S.N.M. No. 50454, and is hereby designated as lectotype. The following specimens were found labeled as paratypes and are here accepted as lectoparatypes: 2, same data as type [Kansas Univ. Colln.]; 2 (♂, ♀), El Rancho, Guatemala, 900 ft., Feb. 17, 1932 (C. N. Ainslie) [U.S.N.M.].

Additional records: ARIZONA: ♀, Douglas, 11-6-1933 (W. W. Jones) [U.S.N.M.]; ♀, Tucson, April 12, 1924 (A. A. Nichol) [Univ. of Minn. Colln.]; 2 ♀ ♀, near Kits Peak, about 3,600 ft., Baboquivari Mts., Aug. 7-9, 1916 [Amer. Mus. Nat. Hist.]; 3 ♀ ♀, same data as type [Kans. Univ. Colln.]. CALIFORNIA: ♂, Palm Springs, July 21, 1930 (T. F. Winburn, R. H. Painter) [Sabrosky Colln.]. IDAHO: ♀, Lewistown, June 5, 1930 (J. M. Aldrich) [U.S.N.M.].

***Lasiopleura capax* (Coquillett)**

Hippelates capax Coquillett, 1898, Jour. New York Ent. Soc. 6: 48 (Illinois).

Hippelates capax Coquillett; Becker, 1912, Anh. Mus. Nat. Hungarici 10: 90 [description repeated.]

Pseudobippelates capax (Coquillett) Malloch, 1913, Proc. U.S. Natl. Mus. 46: 261, fig. 40 [redescription of type; the Florida record belongs under *L. barberi*.]

Pseudobippelates capax (Coquillett) Aldrich, 1931, Proc. Ent. Soc. Wash. 33: 71 [*Hippelates longulus* cited as synonym.]

Lasiopleura capax (Coquillett) Malloch, 1934, Diptera Patagonia and S. Chile, Part VI, fasc. 5: 417 [in key.]

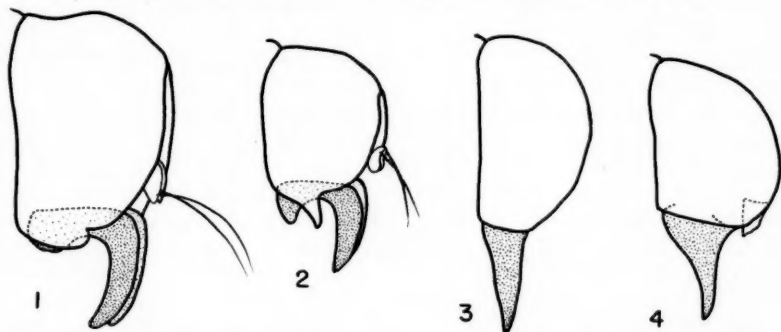
Lasiopleura capax (Coquillett) Sabrosky, 1936, Ent. News 47: 247.

Lasiopleura capax (Coquillett) Sabrosky, 1939, Mém. Mus. Roy. d'Hist. Nat., ser. 2, fasc. 15: 178 [key to separate *capax* and *longula*.]

Lasiopleura capax is a relatively large species (2.5 mm.) with frontal triangle densely and bright gray pollinose, dorsum of thorax likewise but, viewed from behind, with a distinct and broad median stripe of brown pollen and more or less evident brownish pollen on the extreme edges of the mesonotum; pleuron not entirely pollinose, but with a smooth and polished area anteriorly, including an anteroventral elongate-oval area of the mesopleuron, the mesostigma, and an area of somewhat variable extent below the spiracle; front velvet black on the sides outside the triangle, yellow anteriorly, the yellow forming a T-shaped spot by a broad and short median stripe extending forward from the apex of the triangle to join the yellow anterior margin of the front; antenna and arista entirely black.

Front broad, three-fifths the width of the head and 1.0 to 1.2 times its own length; cheek slightly over one-fourth the height of the eye (0.23-0.28 times; 0.27 in holotype) and approximately one-half the breadth of the third antennal segment (0.44-0.54); only the posterior pair of dorsocentral bristles developed.

and that rather weakly, the rest of the dorsocentral row hairlike and no different in appearance from the acrostichals or other hairs; presutural bristle weak, short; posterior notopleural bristle obviously not on same level with the anterior, being well above the lower margin of the notopleuron; apical scutellars erect and cruciate at tips, obviously much longer and stronger than either the subapical scutellars or the posterior pair of dorsocentrals; hind tibial spur moderately strong though not unusually long, its length approximately equal to the greatest diameter of tibia, and preapical by about half its length; male genitalia as in fig. 1.



Figs. 1-4: Side view of ninth tergite and claspers of (1) *Lasiopleura capax* (East Lansing, Mich.), (2) *L. barberi* (paratype, Blackshear, Ga.), (3) *L. hirtoides* (paratype, Dead Run, Va.), and (4) *L. shewelli* (paratype, Hay River, N.W.T.)

Distribution: Apparently mainly northeastern, from the few records: ILLINOIS: 2 (♂, ♀), Dongola, May 10, 1917 [Illinois Nat. Hist. Survey.] INDIANA: ♀, Lafayette, April 9 (J. M. Aldrich) [U.S.N.M.] MICHIGAN: ♀, Alto, April 4, 1936 (E. J. Campau) [Campau Colln.]; ♀, Gladwin County, June 28, 1936 (R. D. Dreisbach) [Dreisbach Colln.]; ♂, Hamburg, April 8, 1934 (G. Steyskal) [Steyskal Colln.]; ♀, Agricultural College, May 7, 1892 [U.S.N.M.]; ♂, Midland, June 5-6, 1936 (Sabrosky); ♂, Battle Creek, May 30, 1938 (Sabrosky); ♂, St. Joseph, May 30, 1938 (Sabrosky); ♀, Saginaw County, June 1, 1940 (Sabrosky); ♂, E. Lansing, April 28, 1942 (Sabrosky); ♀, Kalamazoo, May 10, 1936 (Sabrosky) [Sabrosky Colln.] OHIO: 1 (sex?), Wauseon, Aug. 25, 1902 (J. S. Hine) [Ohio State Univ.] SOUTH DAKOTA: ♀ Canton, June 16, 1924 (F. M. Hull) [Sabrosky Colln.]

The published record from Florida (Malloch, 1913; Johnson, 1913), is referred below to *L. barberi* n. sp. The specimen from Mexico which Malloch recorded has not been found, but it seems doubtful if it is correct as *capax*.

Two specimens from Pass Christian, Miss., Feb. 19, 1946 (J. and W. Rapp) may belong here. The male genitalia are close to those of *capax*, but the pleuron is more pollinose. Another species may be involved, but a decision should await further material.

Lasiopleura barberi, new species

♂, ♀.—As described for *L. capax*, differing in its smaller size (1.5-1.75 mm.), frontal triangle predominantly pollinose but with two irregularly rounded, eye-like, polished spots flanking the ocellar tubercle, the spots occasionally reduced to small areas adjacent to the posterior ocelli; pollinose portions of triangle only sparsely covered with pollen, resulting in a darker and more shining appearance than in *capax*; mesonotum thinly brown-gray pollinose, subshining and not striped; proportions of head almost identical with those of *capax*.

The male genitalia (fig. 2) are quite distinct from those of *capax* (fig. 1), but the other characters are less obviously so. A few specimens of *barberi* have the triangle nearly all pollinose, leaving only small polished spots near the posterior ocelli, and conversely, an occasional specimen of *capax* may show these small polished spots. The habitus of the two is different, though not easy to describe precisely: *capax* is larger, bright and densely gray pollinose, whereas *barberi* is smaller, darker, and more sparsely pollinose.

Holotype male, and allotype, Paradise Key (Royal Palm State Park), Florida, Feb. 21, 1919 (Schwarz and Barber). Type No. 61137 in the U.S. National Museum.

Paratypes: ALABAMA: ♂, Flomaton, June 5, 1917 (J. M. Aldrich) [U.S.N.M.] FLORIDA: 3 ♀ ♀, same data as type; ♀, Biscayne Bay (Mrs. Slosson); ♀, Ft. Myers, July 1, 1937 (J. R. Malloch); ♀, Vero, Feb. 20, 1937 (Malloch); ♀, Sarasota County, March 3, 1937 (Malloch) [U.S.N.M.]; 2 (♂, ♀), Suwannee Springs, Aug. 2-3, 1939 (D. E. Hardy); ♂, Ft. Mead, Aug. 13, 1930 (P. W. Oman); 2 (♂, ♀), La Belle, July 16, 1939 (R. H. Beamer) [Kansas Univ. Colln.] GEORGIA: ♂, Clayton, 2000 ft., May 18-26, 1911 (J. C. Bradley); ♂, Tifton, Sept. 7, 1910 (J. C. Bradley); ♂, Thalman, April 25, 1911; 24 (16 ♂ ♂, 8 ♀ ♀), Blackshear, May 10, 1911 [Cornell Univ. Colln.] MISSISSIPPI: ♀, Horn Island, Aug. 9, 1944, light trap (E. A. Richmond) [U.S.N.M.]

The species is named in memory of the late H. S. Barber, coleopterist, naturalist, collector extraordinary, and good friend.

The Biscayne Bay, Florida specimen was the basis of the records of *Pseudohippelates capax* published by Malloch (1913, Proc. U.S. Natl. Mus. 46: 261) and of *Hippelates capax* by Johnson (1913, Bull. Amer. Mus. Nat. Hist. 32: 87.)

***Lasiopleura willistoni*, n. sp.**

♀.—As described for *L. capax*, but differing in having the frontal triangle predominantly polished, the gray pollen restricted to the ocellar tubercle and the apex of the triangle; front darker than in *capax*, the median yellow stripe not as broad and thus not as conspicuous; cheek with two rows of coarse black hairs; legs almost entirely infuscated, in some specimens even the fore coxa brownish; proportions of front and head approximately as in *capax*; cheek approximately one-third the height of an eye (0.30-0.34) and three-fifths the breadth of the third antennal segment (0.56-0.625); posterior dorsocentral and subapical scutellar bristles slightly stronger than in *capax*, but still obviously much shorter and weaker than the long apical scutellars; hind tibial spur strong but a trifle shorter and less distinct than in *capax*.

Holotype and four paratypes, all females, Socorro, New Mexico (S. W. Williston). Type No. 61138 in the U.S. National Museum. The holotype is labeled "1916", but the other specimens are undated.

A male, same data as type, is probably the same species, but it is headless and is not included in the type series. The male genitalia of this specimen are similar to those of *capax* (cf. fig. 1), but have much more strongly curved forceps.

***Lasiopleura longula* (Becker)**

Hippelates longulus Becker, 1912, Ann. Mus. Nat. Hungarici 10: 89 (cited as "Kanada", an error for Grenada).

Hippelates longulus Becker; Gibson, 1915, Ent. Soc. Ontario, Ann. Rept. 45: 143 [correction on locality, teste Aldrich.]

Pseudohippelates longulus (Becker) Aldrich, 1931, Proc. Ent. Soc. Wash. 33: 71 [synonym of *capax* Coq.]

Lasiopleura longulus (Becker) Sabrosky, 1936, Ent. News 47: 246. [Generic ref.; distinct from *capax*.]

Lasiopleura longulus (Becker) Sabrosky, 1939, Mém. Mus. Roy. d'Hist. Nat., ser. 2, fasc. 15: 177-178 [key to separate it from *capax*.]

Lasiopleura longulus (Becker) Séguy, 1940, Mém. Mus. d'Hist. Nat. n.s., 13 (5): 334.

Some years ago the writer pointed out that *longula* was a distinct species, and he later gave a key to separate it from *capax*. The recognition of another species in the southeastern states necessitated a reexamination of the problem, and because the species are so close, it seemed best to include *longula* in the present key although it is outside the scope of the paper.

The species is close to *L. barberi*, differing as noted in the key. Only the holotype of *longula* sens. strict. has been seen, for the specimens from Cuba recorded by Sabrosky (1939, p. 178) appear to me now to be closer to *barberi*.

***Lasiopleura hirta* (Loew)**

Oscinis hirta Loew, 1863, Berl. Ent. Ztschr. 7: 39 (Centuria III, no. 75) (Illinois).

Oscinella hirta (Loew) Becker, 1912, Ann. Mus. Nat. Hungarici 10: 112.

Lasiopleura hirta (Loew) Malloch, 1934, Diptera Patagonia and S. Chile, Part VI, fasc. 5: 417 [in key.]

Lasiopleura hirta (Loew) Sabrosky, 1936, Ann. Ent. Soc. Amer. 29: 727.

Black, bright gray pollinose species, with front yellow on anterior fourth, the triangle ending at the upper margin of the yellow band; face and cheek whitish; palpus light yellow; antenna orange-yellow, the third segment black on upper third; arista black; legs black, with fore coxa, basal third to half of all femora, and bases of all tibiae narrowly, yellow; halter yellow; pro- and mesopleuron entirely pollinose.

One pair of strong, cruciate interfrontal bristles, immediately posterior to antennal bases; front broad, three-fifths the width of the head and nearly one and one-third times its own length; cheek narrow, one-seventh (0.14) times the height of an eye; strong vibrissa, as long and as strong as the anterior notopleural, and an equally long and strong bristle immediately behind it, followed by a row of coarse, black, forwardly directed hairs near the lower margin of the cheek; four pairs of well-developed dorsocentral bristles, the posterior two pairs long; posterior notopleural bristle at the same level as the anterior bristle, both close to lower margin of the notopleuron; "sensory area" on hind tibia relatively short, barely over one-fifth the length of the tibia. Length, 2.5 mm.

The measurements given above are from a male associated with the type series, apparently part of the original material, and labeled "Osten Sacken Coll." [Mus. Compar. Zool.] The two male cotypes on one mount in the same collection are not now available for measurement, but my older notes on them agree with the above. No other examples of this species have been seen.

Lasiopleura hirta in the sense of Malloch (1934) was based on specimens that are now referred to *hirtoides* and *shewelli*, not on *hirta* in the strict sense.

***Lasiopleura hirtoides*, n. sp.**

♂, ♀.—As described for *L. hirta* except as follows: Brownish-gray pollinose species, slightly darker and not as gray as *hirta*, and somewhat more shining; third antennal segment infuscated on dorsal half in female, on dorsal fourth or fifth in male; femora usually almost entirely infuscated; two and sometimes three pairs of strong, cruciate interfrontal bristles, the uppermost or third pair not always distinguished from hairs; front 0.60-0.64 times the width of the head and 1.11-1.25 times its own length; cheek obviously broader, averaging 0.28 times the height of an eye (0.22-0.38); vibrissa and cheek hairs weaker, the former not as long as the anterior notopleural; only the posterior dorsocentral developed as a long and obvious bristle, though the others are longer than the usual hairs and form a distinct dorsocentral row; "sensory area" nearly three-tenths the length of the tibia, linear; male genitalia as in fig. 3; length, 2 mm.

Holotype male and allotype, Cabin John, Maryland, Sept. 19, 1931 (J. M. Aldrich). Type No. 61139 in the U.S. National Museum.

Paratypes: CALIFORNIA: ♀, Lagunitas Canon, Marin County, March 29, 1908 [Acad. Nat. Sci. Phila.] KANSAS: ♂, Manhattan, Sept. 29, 1934 (Sabrosky) [Sabrosky Colln.] MARYLAND: 6 (4 ♂ ♂, 2 ♀ ♀), same data as type; 5 (2 ♂ ♂, 3 ♀ ♀), topotypic, Oct. 21, 1931 (J. M. Aldrich); ♀, Plummer's Island, March 25, 1914 (R. C. Shannon) [U.S.N.M.] MICHIGAN: ♀, Midland County, June 10, 1944 (R. R. Dreisbach) [Dreisbach Colln.] NORTH CAROLINA: ♀, "N.C." [U.S.N.M.] VIRGINIA: 2 (♂, ♀), Dead Run, Fairfax County, March 26, 1925 (R. C. and E. M. Shannon); ♂, Bon Air, Arlington, July 11, 1937 (J. R. Malloch); ♀, Alexandria, Aug. 17 (J. M. Aldrich); ♀, Mt. Vernon, July 4, 1917, at honeydew (W. L. McAtee) [U.S.N.M.]

Two specimens from South Dakota may belong here, but they differ slightly by having grayer frontal triangle and thorax, less black on the antenna, and broader cheek (0.92 and 0.85 times the breadth of the third antennal segment and 0.39 and 0.42 times the height of an eye.) It is possible that they represent still another species, but much more material would be desirable. A specimen from Ft. Wrigley, Northwest Territory, appears to belong also, but it is in poor condition for study.

Lasiopleura shewelli, n. sp.

♂, ♀.—As described for *L. birta* except as follows: Brown-gray pollinose and rather shining, resembling *L. birtoides*; antenna darker, infuscated on the upper half or more; pleuron with a large, polished black area on the anterior third, comprising the whole area ventrad of the anterior spiracle and extending posteriorly to include the antero-ventral third of the mesopleuron; two to three pairs of strong, cruciate interfrontal bristles; front approximately as in *birta* and *birtoides*, 0.59-0.63 times the width of the head and 1.10 to 1.23 times its own length; cheek broader than in *birta*, averaging 0.28 times the height of an eye (0.23-0.31); dorsocentrals as in *birtoides*, not as strongly developed as in *birta*, only the posterior pair very obvious; "sensory area" linear, comparatively long, slightly over one-third the length of the tibia; male genitalia as in fig. 4; length, 2-2.25 mm.

Holotype female, Dundas Marsh, Ontario, 1948 (W. W. Judd).

Paratypes: ♀, same data as holotype; ♀, Norway Bay, Quebec, Aug. 27, 1938 (G. E. Shewell); ♀, Orillia, Ontario, July 15, 1923 (C. H. Curran); ♂, Hay River, Northwest Territory, Sept. 10, 1932 (O. Bryant); ♂, Grosse Ile, Wayne Co., Michigan, Sept. 12, 1948 (Geo. Steyskal). Type and paratypes in Canadian National Collection, Ottawa; paratypes in U.S. National Museum and Sabrosky Collection.

Lasiopleura itascaae, n. sp.

♂, ♀.—As described for *L. birta* except as follows: Brown-gray pollinose and rather shining, somewhat intermediate between the gray *birta* and the darker *birtoides* and *shewelli*; femora sometimes almost entirely infuscated; pleuron with two polished black spots, one a subquadrate area below the mesostigma, the other an elongate-oval anteroventral spot on the mesopleuron, the two separated by a vertical band of bright gray pollen; only one pair of strong, cruciate interfrontal bristles; cheek narrow, averaging 0.155 times the height of an eye (0.13-0.18); two pairs of fairly well-developed dorsocentral bristles, as in *birta*; "sensory area" on hind tibia approximately three-tenths the length of the tibia; male genitalia intermediate between those of *birtoides* and *shewelli*; length, 1.75 mm.

Holotype male and allotype, Itasca Park, Minn., Aug. 14, 1950 (H. T. Spieth). Type No. 61140 in the U.S. National Museum, deposited through the courtesy of the collector.

Paratypes: 6 (4 ♂♂, 2 ♀♀), same data as holotype; 6 (2 ♂♂, 4 ♀♀), topotypic, emerged Aug. 23, 1950 [U.S.N.M., Univ. of Minn. Colln., and Amer. Mus. Nat. Hist.]; ♀, Detroit, Michigan [U.S.N.M.]; 4 (♂, 3 ♀), Goldsboro, North Carolina, Oct. 21, 1922 [Amer. Mus. Nat. Hist. and Sabrosky Colln.]

The series from Itasca Park was reared as a result of an intensive search for the larvae of the rare *Drosophila lacicola*. The two species were found together, and I am indebted to Dr. Spieth for the following notes on the habitat: "They were breeding in the rotting phloem tissue of aspen cord wood which was stacked beside a pond. The particular bark the flies chose was that which was just decomposed to the point that it could be pulled loose from the logs. It was a dark brown color, moist, and had the typical odor that is characteristic of aspen pulp. Burrowing in the rotten phloem tissue were the larvae of *D. lacicola* and *Lasiopleura*. The larvae migrated to the exposed ends of the bark and pupated there. These ends were rather dry and frazzled. Apparently these two species are the first insect invaders of this bark. Bark that was older and therefore had rotted more and lacked the characteristic odor, although as wet and damp as the fresher bark, did not contain either of these species." A note on this breeding site of *Drosophila lacicola* has been published by Spieth (1951, Science 113: 232).

Lasiopleura spp. from Panama

In addition to *Dasiopleura grisea*, Malloch (1934, op. cit., pp. 417-418) described two new species in his key, listing them only as "Panama." Types and paratypes of these species were labeled in the collection of the U.S. National Museum, and these are accepted as such and lectotypes are hereby formally designated. The types each bear Malloch's handwritten label as "Type."

Lasiopleura birtiventris Malloch: Lectotype, male, Trinidad Rio, Panama, March 18, 1912 (A. Busck). Lectoallotype, and five lectoparatypes (♂, 4 ♀♀), same data. Type No. 50453 in the U.S. National Museum.

Lasiopleura panamensis Malloch: Lectotype, male, Alhajuelo, Panama, April 7, 1911 (A. Busck). Lectoparatypes: 28 (11 ♂♂, 17 ♀♀), same data as type; 2 ♀♀, Trinidad Rio, Panama, March 18, 1912 (A. Busck). Type No. 50455, U.S. National Museum.

A Note on Some Preliminary Observations on the Effect of the Antibiotic Terramycin on Insect Symbiotic Micro-organisms

By A. J. MUSGRAVE¹ AND J. J. MILLER²

Micro-organisms that seem to be symbiotic are known to occur in many insects (Steinhaus, 1949). Often these micro-organisms are retained for at least a part of their life in special organs in the insect's body called 'mycetomes'. Mansour (1935) following a study of a number of beetles containing micro-organisms concluded, in the two closely related species *Sitophilus granarius* (L) and *Sitophilus oryza* (L) that while both species have mycetomes only *S. oryza* had micro-organisms; a conclusion that has received some general acceptance (Steinhaus, 1946; Wigglesworth, 1947). Thus it could be questioned if the micro-organisms in *S. oryza* were of benefit to it since *S. granarius* survived apparently without any (Mansour). However, it has been shown that in some

¹Department of Entomology and Zoology, Ontario Agricultural College, Guelph, Ont. This work forms a preliminary contribution towards fulfillment of requirements of advanced degree of McMaster University.

²Department of Botany, McMaster University, Hamilton, Ont.

beetles (Blewett & Fraenkel, 1944), in the body louse (Aschner, 1935), and in the bug, *Rhodnius*, (Brecher & Wigglesworth, 1944) the associated micro-organisms are of considerable importance to the insect. It therefore seemed worth while to study further the condition existing in *S. oryza* and *S. granarius*; and in the early stages of this work some interesting phenomena have been observed.

Confirmation of the presence of the micro-organisms in the mycetome, the mid gut coeca and the ovarioles (Murray & Tiegs 1935) in *S. oryza* has been obtained visually in this work. The *absence* of similar micro-organisms in *S. granarius* was not so readily confirmed visually. However, if *S. oryza* contains micro-organisms that play an essential part in its physiological economy, while similar micro-organisms are absent in *S. granarius*; then if an antibiotic of appropriate kind be administered it might well be that the metabolism of the two beetle species would be affected quite differently. It would seem not unreasonable to anticipate serious metabolic disturbance resulting in death, retarded development or sterility in *S. oryza* and little or no disturbance in *S. granarius*. Some experiments were therefore carried out to test this idea.

Wheat grains were sorted approximately as to size in accordance with Ewer's (1945) indication that in experiments with *S. granarius* in which uniform oviposition was desired wheat grains of uniform size should be provided. The grains were then weighed as 2 gram samples into small glass vials and treated with aqueous acidified solutions of Terramycin hydrochloride (Regna & Solomons, 1950; and Weyer, 1950). Acidification was found to be necessary to avoid the iso-electric point and consequent precipitation of the Terramycin in the solution. Half the vials received 2 ml of acidified Terramycin, the other half, the checks, received 2 ml of acidified water. After soaking, the grain in the vials was dried in an oven at 40-50°C. From stock cultures of the two weevils replicate vials of grain were supplied each with 20 weevils of one species. As Richards (1948) has found two physiological races of different size in *S. oryza* it was thought desirable to select the largest available specimens of each species. There were twelve vials: two species of weevils each receiving two different treatments; each treatment in triplicate. The arrangement of the experiment can be deduced from Table I. Each vial was placed in a separate humidor placed in an incubator so that conditions approached as nearly as possible to 26-27°C. and 76% Relative humidity; conditions that seemed near optimum for the weevils, (Reddy, 1950; Ewer, 1945). The tops of vials were covered with bolting silk held in place by Johnson's waterproof adhesive tape. After 72 days a count of weevils was made and the results are shown in Table I. During the experiment some *S. oryza* did escape from two check vials and drown in the salt solution. They were included in the population counts as live weevils and it may well be that their escape had a lowering effect on the counts of weevils in these check vials; thus falsely decreasing the difference between check and treated populations and making the results less dramatic.

Both species of *Sitophilus* feign death; behaviour that complicates mortality counts. But by the simple procedure of subjecting doubtful insects to the light and heat of a bench lamp some approximate idea of mortality could be obtained; and these figures are given in the Table. A second count was made about 40 days later and confirmed the trend shown in the first; as did the results of a second experiment in which lower doses were used. The technique in the second experiment was, however, less satisfactory.

A brief account of these preliminary investigations has been presented at this time as the results do suggest that *Sitophilus oryza* fed Terramycin treated grain is disturbed metabolically to a markedly greater extent than *Sitophilus*

TABLE I.
FIGURES ARE MEANS OF THREE REPLICATES

	<i>S. oryza</i>		<i>S. granarius</i>	
	Fed water treated grain	Fed Terramycin treated grain	Fed water treated grain	Fed Terramycin treated grain
Number at start	20	20	20	20
Number after 72 days	79	24	57	41
Population increase	59	4	37	21
Approximate % mortality	11	84	11	32
Condition of grain	B	C	A	B

Dose: 0.036 grammes Terramycin per gramme of grain — a very high dose.

Acidification: Approximately 1 ml *N* HCl to 10 ml solution or distilled water.

Condition of grain: A — very well eaten — only husks and powder.

B — well eaten.

C — eaten slightly.

granarius similarly treated. This difference may be due to inhibition of vitally important symbionts in *Sitophilus oryza*.

Apart from their general interest to entomologists and microbiologists the results are noteworthy in that they indicate the distinct and attractive possibility that control of certain important insects that are said to have mycetomes (e.g. Aphids, body lice, and some wood feeding beetles) may be achieved by means of antibiotics. This would seem to be a fruitful field of research. The work is being continued and elaborated.

Thanks are gladly tendered to Professor A. W. Baker, Ontario Agricultural College and Professor N. W. Radforth, McMaster University and Royal Botanical Gardens, Hamilton, in whose departments this work was done; and to the Pfizer Chemical Corporation for the sample of Terramycin.

Literature Cited

- Aschner, M. 1934. Studies on the symbiosis of the body louse. I Elimination of the Symbionts by centrifugalisation of the eggs. *Parasitology* 26: 309.
- Blewett, M. & Fraenkel, G. 1944. Intracellular symbiosis and vitamin requirements of two insects, *Lasioderma serricornis* and *Sitodrepa panicea*. *Proc. Roy. Soc. Lond. (B)* 132: 212.
- Brecher, G. & Wigglesworth, V. B. 1944. The transmission of *Actinomyces rhodnii* Erikson in *Rhodnius prolixus* and its influence on the growth of the host. *Parasitology* 35: 220.
- Ewer, R. F. 1945. The effect of grain size on the oviposition of *Calandra granaria* Linn. (Coleoptera Curculionidae). *Proc. R. ent. Soc. Lond. (A)* 20: 57.
- Mansour, K. 1935. The so-called Symbiotic relationship between Coleopterous insects and intracellular micro-organisms. *Quart. J. micro. Sci.* 77: 255.
- Murray, F. V. & Tiegs, O. W. 1935. The metamorphosis of *Calendra oryzae*. *Quart. J. micro. Sci.* 77: 405.
- Reddy, D. B. 1950. Ecological studies of the rice weevil. *J. econ. Ent.* 43: 203.
- Regna, E. P. and Solomons, I. A. 1950. Chemical & Physical properties of Terramycin. *Ann. N.Y. Acad. Sci.* 53: 229.
- Richards, O. W. 1948. The two strains of the rice weevil *Calandra oryzae*. *Trans. R. ent. Soc. Lond.* 94: 187.
- Steinhaus, E. A. 1946. *Insect microbiology*. Comstock.
- Steinhaus, E. A. 1949. *Principles of Insect Pathology*. McGraw Hill.
- Weyer, E. R. 1950. A report on Terramycin. *J. Amer. Pharm. Assoc.* 11: (4): 230.
- Wigglesworth, V. B. 1947. *Principles of Insect Physiology*. Methuen.

A Technique for Mass-Marking Honeybees

By M. V. SMITH AND G. F. TOWNSEND

Department of Apiculture, Ontario Agricultural College
Guelph, Ontario

The study of honeybee behaviour and activity requires, among other things, some means of positively identifying both individuals and groups of honeybees. Research workers have for years applied quick drying paints to the thorax or abdomen of the honeybee for this purpose. However, where large numbers of bees must be marked, the hand application of paints is a rather slow and tedious procedure and at its best allows for the marking of a comparatively small number of insects.

Several alternative methods of mass-marking honeybees have been suggested. Singh (1950) attempted to dust field bees with bright powders but found that they cleaned the powder from their bodies and the colour soon faded. Smith *et al* (1948) describe techniques used to mass-mark honeybees both in the field and at the hive. In the field, foraging bees were sprayed with a small hand atomizer containing titanium dioxide in alcohol. This coloured the bees white and enabled them to be identified quite readily. At the hive, returning field bees were sprayed with an alcoholic solution of basic fuchsin. Subsequent collections of foraging bees were killed in a cyanide bottle, placed on a paper towel and moistened with alcohol. Traces of red indicated marked bees.

A method somewhat similar to the above is herein described, whereby all honeybees leaving a hive are automatically marked. It is felt that this method should provide an excellent opportunity for studying certain problems relating to the use of honeybees for pollination, including:

- (1) Following the actual dispersal of foraging honeybees from a given source.
- (2) Estimating the number of colonies per acre required to pollinate a given crop.
- (3) Determining the effect of location and time of placing of honeybee colonies used for pollination.
- (4) Measuring the efficiency of training honeybees to a specific crop.

General Technique

Fluorescent compounds as suggested by Musgrave (1949) were used in this study. A set of marking blocks which would fit the entrance of a standard hive was devised. All bees leaving or entering the hive were simply forced to walk between two strips of velveteen liberally dusted with the fluorescent marker. It was found that sufficient powder would adhere to the legs and body of the bees to permit identification. Collections of field bees were killed, placed on a sheet of white paper and moistened with a drop of water. In most cases the soluble marker would diffuse into the water, giving a readily discernible colour. The moistened bees were then subjected to ultra-violet radiation in a darkened room, whereupon those bees which carried such minute traces of the marker that the water droplet showed no actual colour, could now be readily identified.

Fluorescent Markers

To be acceptable as a marking material, a compound must be highly fluorescent in a distinctive colour, adhere readily to and be non-toxic to honeybees. Of a number of compounds that were tested, fluorescein, Dupont rhodamine B extra, and a product listed as Ultra-Lite Blue¹ fluorescent activator were found

¹A mixture of the mono-sulphonic acid sodium salt of dehydrothioparatoluidine and para-aminophenyl-toluthiazol.

to be satisfactory for this purpose. These compounds fluoresced a brilliant green, red and blue, respectively. In addition, certain finely powdered fluorescent solids were tested, with good results. However, most of the work to date has been conducted with the fluorescein and rhodamine.

Marking Blocks

In operation it was found that the marking blocks should be spaced with an opening $\frac{3}{8}$ " to $\frac{1}{2}$ ". Below $\frac{3}{8}$ " crowding and congestion were apparent, while above $\frac{1}{2}$ " some bees tended to fly through the opening and thus avoided being marked. It was found advisable to place dummy marking blocks on hives several days before they were required for an experiment, to enable the bees to become used to them. On hot days hives were provided with additional top ventilation while the marking blocks were in place.

Marking Efficiency

A set of marking blocks was dusted with the fluorescent marker and placed on the entrance of an empty hive in the laboratory. A number of bees were brought in and released inside the hive. They at once escaped through the entrance and flew to the window, where they were captured and tested. One hundred per cent (100%) marking was obtained in these tests.

The same marking block, without further addition of the fluorescent powder, was placed on a colony outside and at the end of an hour it was brought in and tested as before. Again, 100 per cent marking was obtained. Further tests indicated that after up to three hours in operation 95 per cent or more of the bees were still being marked.

Collection of Bees

A. *At the Hive*—The hive entrance was closed for a few minutes and incoming field bees were captured at the entrance, using an insect net. It was found that by placing a clean paper towel in the bottom of the net after each sweep and by killing the bees immediately by exposing the whole net to cyanide fumes no contamination of unmarked bees occurred.

B. *In the Field*—The most satisfactory method of collecting field bees was to capture each insect in a separate vial. Vials with perforated lids are preferable, since the bees can easily be killed by placing all the vials in a container and exposing them to cyanide fumes.

Population Build-Up of Marked Bees

Collections of bees made both at the hive entrance and in the field indicated that from one to one and one-half hours must elapse after placing of the entrance before marking reaches its peak. Marking entrances were therefore always placed on colonies one and one-half hours in advance of each experiment, and the fluorescent marker was replenished immediately before field collections were commenced.

Persistence of Markers

The fluorescent markers used were found to be very persistent, and marked bees could often be recovered several weeks or more after the entrances had last been used. The interior of the hive was often deeply stained, and honey combs, honey and even honeybee larvae frequently were tinged with colour. Adult honeybees readily ingested the powder and showed highly fluorescent intestinal tracts. This effect was most pronounced with the rhodamine compounds. However, no ill effects could be observed from the use of these fluorescent markers.

Since the marking compounds are so persistent it would not be advisable to use a fluorescent marker on a colony that had previously been used with some

other colour. Care should also be taken to avoid contamination of commercial equipment, by using markers only on experimental colonies.

Field Tests

In carrying out field tests choose a suitable location for the experiment. Large fields should be avoided, since they will require large collections of field bees to be made and usually the recovery of marked bees will be so small that results will be questionable. A field not larger than ten acres and with no large concentration of bees in the immediate vicinity, other than the marker colonies, should provide a satisfactory experimental area. By using two or more different coloured markers simultaneously the dispersal of foraging bees from groups of colonies in different locations in the same field can be studied and compared.

In tests carried out on a 5-acre red clover field, using only four marker colonies, as high as 75 per cent recovery of marked bees was obtained in field collections. Collections made in different parts of the field indicated that wind direction and the direction the colony entrance was facing had a noticeable influence on the dispersal of foraging bees. By taking simultaneous pollinator counts and collections of foraging bees it was shown that in the field under study three colonies of honeybees per acre were required to maintain a concentration of one bee per square yard on second growth red clover bloom.

Summary

A comparatively simple and inexpensive technique has been developed whereby all the honeybees passing through the entrance of a colony are automatically marked. The efficiency and persistence of the fluorescent compounds used as markers was found to be quite satisfactory. Subsequent identification was greatly facilitated through the use of ultra-violet radiation. It is hoped that this technique may provide a useful tool for further studies in the behaviour of honeybee colonies.

This technique was developed to aid in honeybee pollination studies as part of the program of the Legume Research Committee in Ontario.

References

- Musgrave, A. J. (1949)—The Use of a Fluorescent Material for Marking and Detecting Insects. *Can. Ent.* 81: 173.
Singh, Sardar (1950)—Behaviour Studies of Honeybees in Gathering Nectar and Pollen. Cornell University Ag. Exp. Sta. Memoir 288.
Smith, R. F., J. W. MacSwain, E. G. Linsley, and F. R. Platt (1948)—The Effect of DDT Dusting on Honeybees. *Jour. Econ. Ent.* 41: 960-971.

